

Daniel Drucker  
Dean of Engineering

Those of you who joined us last year will recall the proud announcement of our selection by 132 Deans of Engineering across the country as the number two College

## Welcome to Engineering Open House

of Engineering, along with Stanford. In the intervening year, students and faculty continued to try harder. They now have much to show you that is new, interesting, and important, from basic science through to immediately applicable aspects of construction, production, and design. Our colleagues from the School of Chemistry and Computer Science have joined with us to provide still broader coverage for you.

The theme, "Revolutions in Engineering," was chosen by our students. It expresses both the truly revolutionary effect on the peoples of the world produced by the innovative men and women of engineering and the complementary revolutionary effects

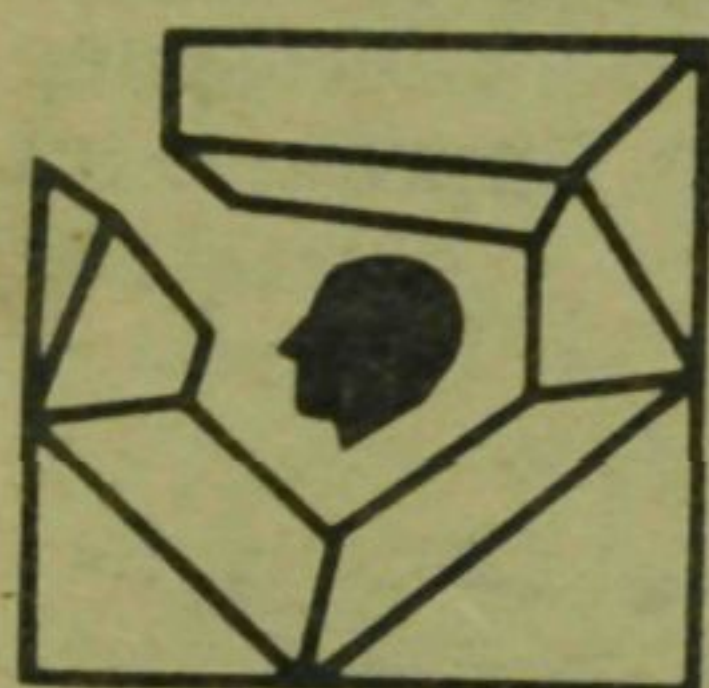
on engineering produced by the rapidly changing aspirations of people in this country and those less fortunate. Our students and faculty, as you, feel the need to help contribute to the solution of the pressing problems of society. Energy, materials, food, housing, transportation, health care delivery, and employment opportunities, all fall far short of meeting the world's needs. Adverse environmental impacts of our past and present efforts to meet societal demands will multiply tenfold in the future unless vastly improved engineering solutions than now exist can be devised. Our students, as the engineering practitioners of the future, must build on the very high level of

existing knowledge and then must do much better than we have. They will have to go far beyond a simple awareness of the economic, political, and sociological aspects of technical problems. They will be required to offer alternative designs or solutions which best meet all of the constraints imposed by individual and societal values.

Engineers must create technologies with accompanying social benefits at acceptable economic and social costs. To do less is to fail as an engineer. This is why so much of what you see reflects our very extensive engineering research activity.

Explore engineering and science with us—welcome to Engineering Open House 1976.

D. C. Drucker



# revolutions in engineering

March 5 and 6, 1976

## Dr. Bitzer to speak



Dr. Donald L. Bitzer

by Fred Kroner

"Paging dib of course e. Paging dib of course e."

No, it's not a garcon at the local restaurant interrupting a patron during the main course of a Sunday evening meal, but it is indeed a way to get in touch with Donald L. Bitzer, chief inventor of the PLATO system and this year's guest speaker at the SITE (Student Introduction to Engineering) banquet.

And judging from his comments, one might be led to believe that eventually getting in touch with a neighbor or friend will be as easy as going to the nearest terminal.

This computer network system, developed by Bitzer, has expanded not only throughout the United States and Canada, but Europe as well. "We've had movable units in Stockholm, Bucarest, Frankfurt, Paris and Moscow to name a few," Bitzer reflects.

The current number of PLATO outlets, nearly 1000 in approximately 100 different locales sounds impressive in itself. And when Bitzer adds, "We've committed ourselves to aid in the instruction of 150 different courses next semester, including roughly 500 students in computer science and an additional 500 in ac-

countancy, plus nearly 1000 more in foreign languages," one would think that the age of computers has dawned.

### Future Projections

Bitzer states with calm assurance a few projections for the future. The future—as in 1980—five years from now. Oh, where are you now, George Orwell?? Bitzer outlines what he anticipates of PLATO five years hence.

"I am looking for a world wide network in excess of one million terminals; a system that will be inexpensive enough for people to have in their own homes. It will be an entirely different system with many new features from what we now have."

"For example, maybe a two million volume library—like the University's complete set, and I mean the whole set; also weather service, stock markets and other options in addition to current features such as answering services, message options, talking options, games and of course educational opportunities."

And what was it you were saying about the cost?

"I would think that we could expect 35 cents an hour for everything; or if a person bought one for his home, it might be equivalent to what a good color television set would cost now. Then, maybe 15 cents an hour to cover the cost of the connections." (PLATO systems must operate on phone lines, although Bitzer envisions the eventual use of satellites.)

### Many Advantages

"I feel that this will turn into a major asset. Besides providing entertainment, there will be many extra services that will provide help for people. We should have attachments to teach people to fly or drive or other simulated training. I also hope to have voice recognition—where you can speak into the computer and it will understand you. Also it will help in general understanding and world wide communications. People

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## COMMENTARY

by L. E. Schulz

This year the College of Engineering is sponsoring its 67th Open House. Open House has become an annual event which attracts 20,000 to 30,000 visitors. These visitors come for a variety of reasons: Some are amazed at the displays, they are fascinated by moving pieces and marvel at electronic games. They often bring their children to enjoy a day of learning. Others are high school students, they come to get a glimpse of engineering and of the University of Illinois. For them, Open House provides a chance to learn more about the college before deciding where they wish to attend college. Still others are participating in the College of Engineering's "Student Introduction to Engineering" (SITE). This program provides an opportunity for high school juniors and seniors to visit classes and stay overnight in a university dorm. Some are guests of the School of Chemistry, which is participating in Open House for the first time this year.

The theme this year, Revolutions in Engineering, is particularly appropriate. Much has been said and written about the role of engineering in contributing to the success of the United States. The industrial revolution completely restructured American

society. Advance technologies were responsible for the success in the second world war. Landing a man on the moon stands as one of the greatest technological achievements of all times.

The displays of Open House reflect the awesome advances which American technology has achieved. As you view each exhibit, pause and reflect on the years of development necessary to make the exhibit possible. Then think of the long hours students spend solving practical problems to create an exhibit that reflects recent technological developments.

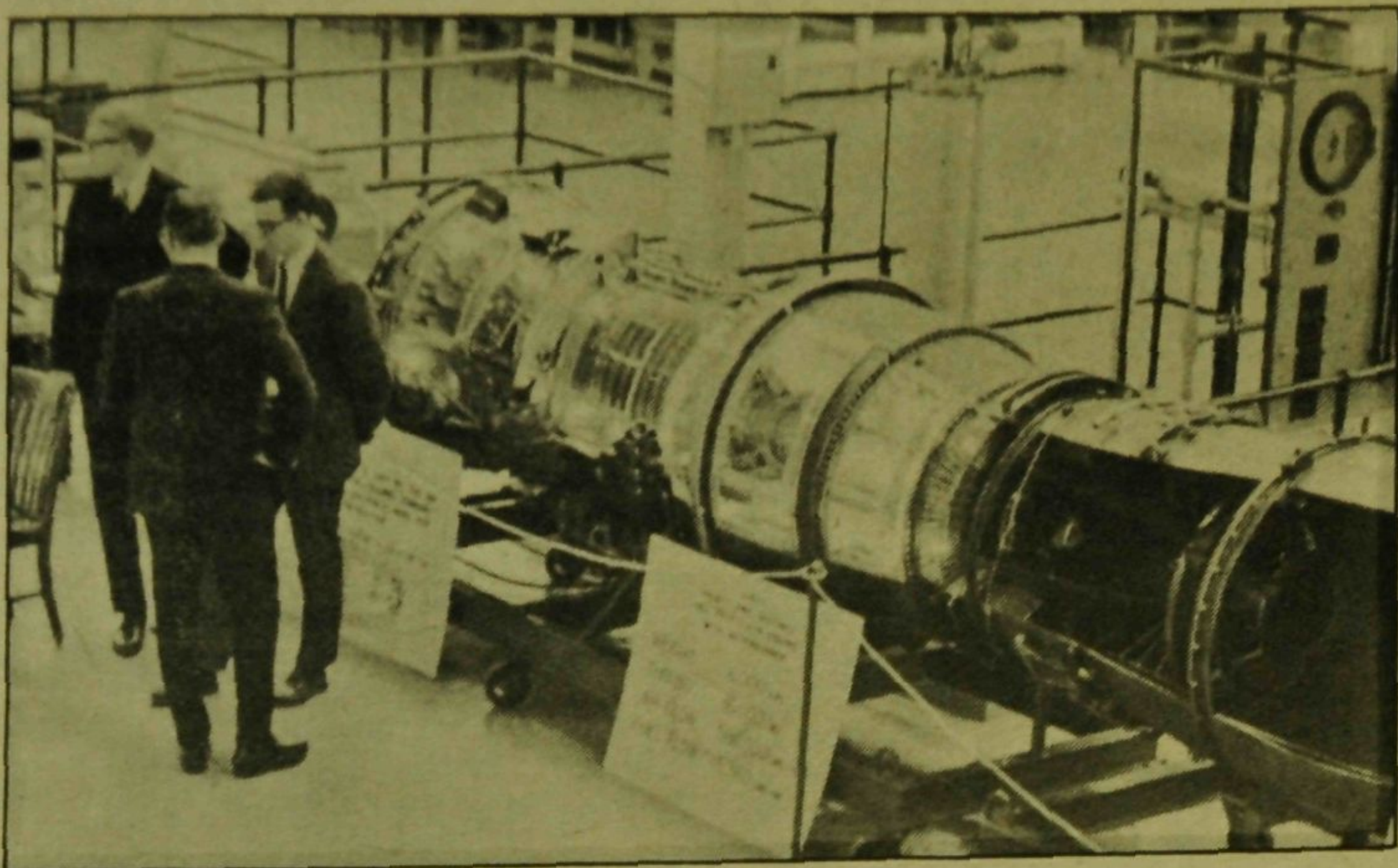
Engineering is advancing beyond merely achieving technological marvels. Once the engineer considered primarily three questions: Can I do this? How can I achieve this? What is the least expensive method? Now, the engineer must also ask what is the effect of this design on the environment and what impact will it have on society. As early as 1952, engineers had prepared extensive reports documenting the upcoming energy shortage. This is the new challenge, the new revolution, in engineering—Design with a knowledge and consideration for the sociological and ecological impact of a project.

## The buck stops here

One indication of quality in an educational institution is how many research dollars it attracts and spends for its projects. The College of Engineering, University of Illinois at Urbana-Champaign, led the nation in fiscal year 1974 with separately budgeted research expenditures of \$18,644,000. When other major engineering-related research is included, UIUC's total is \$26,949,000, second only to that of the Massachusetts Institute of Technology.

In the American Society for Engineering Education's latest Engineering College Research and Graduate Study report, 195 engineering colleges and 14 engineering and technical college affiliates reported a total of \$468,595,000 in engineering and engineering-related research for FY 1974. Representing 5.7 percent of the total, UIUC's expenditures have apparently proven a worthwhile investment for the varied areas and interests to which they have been applied.

# AERONAUTICAL & ASTRONAUTICAL



One of the exhibits at a previous Open House was a 600 lb. jet propulsion engine.

## Quiz

by Engineering Speakers Bureau

1. To prepare for a college education in engineering at the University of Illinois, a student should have  $3\frac{1}{2}$  years of math and 2 years of a foreign language? TRUE FALSE
2. In the state of Illinois there are (3,5,7) accredited engineering schools.
3. At the University of Illinois at Urbana-Champaign, the fall semester enrollment deadline for engineering is December of the previous year. TRUE FALSE
4. The number of engineering graduates for the school year 1975-1976 is approximately (25,000 35,000 50,000).
5. The number of engineering graduates needed for industry, as measured by the U.S. Department of Labor for 1976, is (30,000 40,000 50,000).
6. Starting salary for graduating engineers is about (\$9,000 \$12,000 \$15,000) per year.
7. About (1 percent, 5 percent, 10 percent) of all engineering freshmen are women and the increase in demand for women engineers for school year 1974-1975 was (10 percent, 50 percent, 100 percent).
8. (1 percent, 4 percent, 7 percent) of all engineering graduates represent minority groups.
9. First and second year pre-engineering programs exist at (most,  $\frac{1}{2}$ , few) of the Illinois Community Colleges.

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Basic to the Aeronautical and Astronautical Engineering (AAE) curriculum is the study of solid mechanics, propulsion, fluid mechanics, thermodynamics, orbital mechanics, structures, and control systems. The curriculum also allows the AAE student to choose from many elective studies in the humanities and social sciences as well as in science and technology.

The knowledge and abilities developed by an aeronautical or astronautical engineer can be applied to a multitude of problems in both society and industry. Aerospace engineers are involved in the solution of air and noise pollution and mass transportation problems. In addition, space research spinoffs can provide new knowledge in medicine, bio-engineering, and energy technology. The energy crisis has

accelerated research in the development of alternate energy sources. These problems are being solved by aerospace engineers and their knowledge of structural mechanics, fluid mechanics, thermodynamics, and control systems. The talents of aerodynamicists are needed to design wind-driven electrical generators. Thermodynamics and structural and fluid mechanics are tools necessary for the development of coal gasification plants which extract clean energy from dirty coal.

The Aeronautical and Astronautical Department, therefore, prepares students for participation in the continuing exploration of space and for the application of aerospace technologies, to the improvement of life on earth.



A glider plane was one of the displays which Aeronautical Engineers exhibited in a recent open house.

## Engineering Council supports students

by W. D. Harris

Engineering Council is the student government in charge of representing the engineering student in all matters concerning their academic welfare. The Council has an advisory committee that deals directly with the deans of the college. Recommendations to the College Policy and Development Committee are also made by Council. Each Professional engineering society is allowed two representatives and each honorary society one.

The Educational Affairs Committee of Council has one of the most important jobs in handling all academic affairs of Council. Most recently, this committee has arranged student trips to companies in Illinois and as far away as Tonawanda, New York. Often times the companies pay for part or all of the student's expenses. In addition, the committee had arranged for short courses to be held over semester break in areas such as welding, machine shop, small engine repair, sheet metal working, and a few flight refresher courses for those students interested in flying. The committee has also evaluated several courses which resulted in significant changes to be made in course content and methods in teaching the course. Future projects include library im-

provements, solicitation of summer engineering jobs for students and continued evaluation of courses.

We have three major projects that are directed toward the high school student. These are Engineering Open House (EOH), SITE (Student Introduction to Engineering) and Speaker's Bureau.

Engineering Open House is held in the spring every year. Its purpose is to inform both the student and the general public of the importance of engineering and to acquaint students to engineering, here at the University of Illinois. Between 20,000-30,000 visitors view the exhibits, displays and projects designed by the students of the various departments. Council oversees and coordinates this effort.

Our second program, SITE, is a program through which high school students have the chance to see the campus and tour the various departments and attend a few classes and labs. The students preregister through the mail using forms sent to their high schools by Council. On the day before Engineering Open House, these students arrive on campus in the morning and register. That afternoon are the tours and in the

evening is a banquet. The deans of the college and other prominent people in the college attend the banquet. At the banquet is also a renowned speaker of the engineering profession who speaks in areas pertinent to today and tomorrow.

Speakers Bureau is a group of volunteer engineering students who return to their high schools and talk to students about engineering, college life, and the University of Illinois. Over 100 high schools and junior colleges in the state were visited this year.

Engineering Council also sponsors social events such as our annual basketball tournament with over twenty societies and independent teams participating. Our Biggest social event of the year is St. Pat's Ball, a semi-formal dance which received its name from the patron saint of engineers, St. Patrick, and which is held around St. Patrick's Day. It was started back in 1950 with the idea to recognize and honor outstanding students who have devoted their time and effort for the betterment of their society, the engineering college and other engineering related activities.

In addition to the above programs and events, Engineering Council recognizes achievements in teaching excellence and im-

provement of student-teacher relations. The Everitt Award is given to two outstanding teachers as determined by both student nominations and faculty recommendations. Selection procedures are rigid in order to insure that the best candidates are chosen. The Pierce Award goes to one student and one teacher who have encouraged and helped develop better relations between students and faculty within the college. The award recipients are chosen on the basis of student nominations and letters of recommendation from both students and faculty.

This year's Engineering Council has broadened its scope to become involved in campus wide affairs and student government. We will continue this effort and search for new and better ways to help the engineering students on this campus.

Finally, we hope to expand and improve our programs for the high school students in order to make them better aware of what engineering is and what it is like at the University of Illinois. Those of you who have become engineering students on this campus are encouraged to help in whatever way you can with the activities of Engineering Council.

# AGRICULTURAL ENGINEERING

by P.M. Walker

Agriculture must provide the productivity to feed, shelter, and clothe over three billion persons. To do this effectively, the agricultural industry needs a massive amount of engineering technology.

More than 50 colleges and universities across the U.S. have recognized this tremendous need for engineers trained to meet the needs of the agricultural industry and have established programs in Agricultural Engineering. The University of Illinois is proud to be an internationally recognized leader in this field.

The task of providing the engineering necessary for the agriculture industry is not simple. Many types of engineering expertise are required of the Agricultural Engineering profession. Therefore, the profession is divided into five divisions, each providing special employment opportunities now and for the future. These five divisions are:

**Power and Machinery.** The research, design, development, and sale of farm tractors, machinery, and equipment. Improved modern agricultural equipment demands more engineering. Declining farm population has increased the demand for innovative engineers. Agricultural Engineers with imagination will be needed to adapt new energy sources and materials to present tillage, planting, cultivation, harvesting and handling equipment, and to the mechanization of crops now requiring intensive field labor.

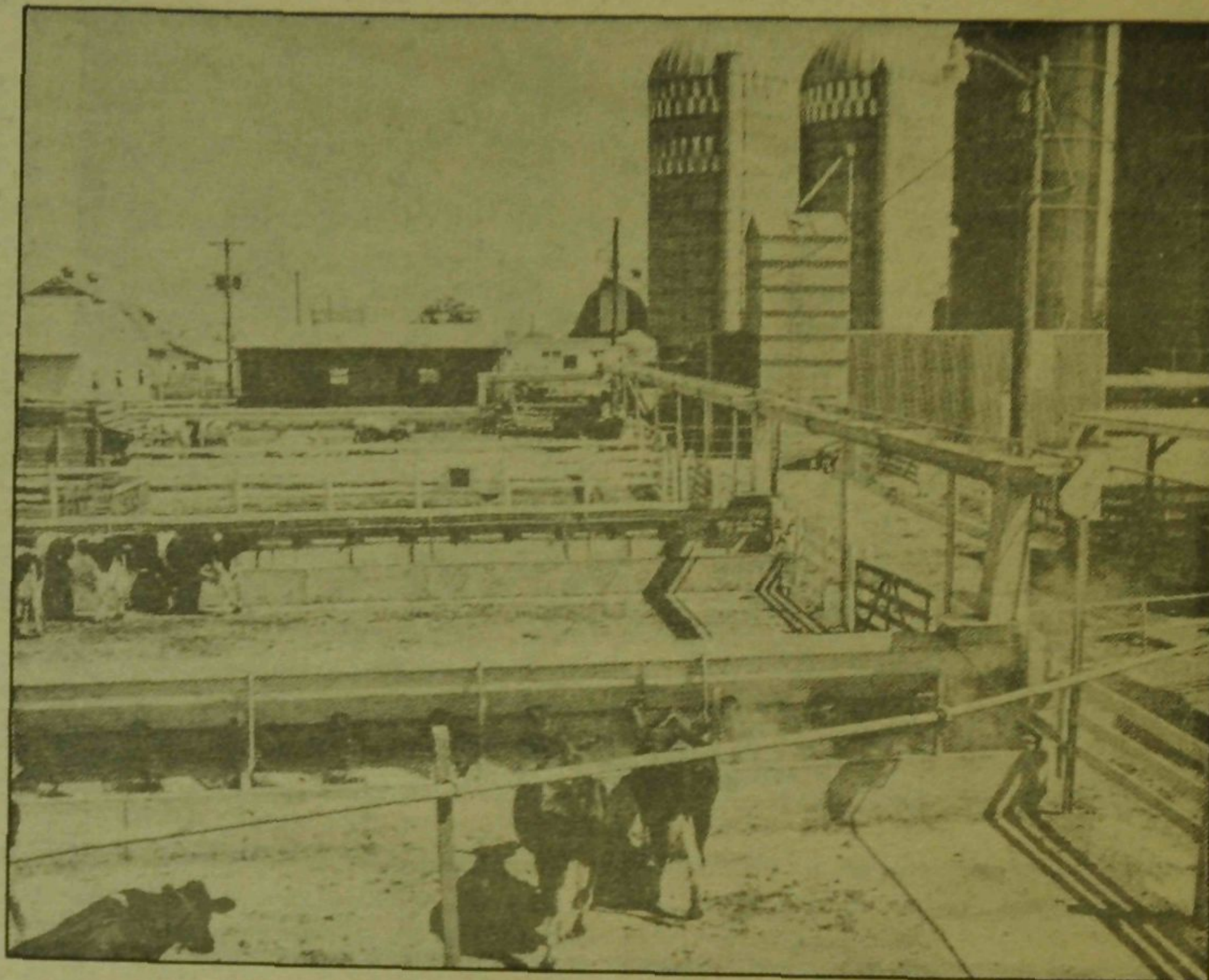
**Soil and Water.** The application of irrigation, drainage, erosion

control, land and water management practices, to the wise use and preservation of our vital soil and water resources. As world population increases, with greater demands for food, lands not now in production must be reclaimed and lifegiving water must be brought to arid areas.

Agricultural engineering—in shaping and surfacing fields, terracing, canal design, pond construction—is a major factor in economic agricultural production. Rapidly increasing demands on existing water supplies place added emphasis on sound water use and conservation practices.

**Electric Power and Processing.** The application and use of electrical energy for agricultural production; feed and crop processing, handling, grading; and for performing various work chores around the farmstead. "Automatic farming" requires extensive use of computers, electronics, quality control devices, electrical systems, materials handling equipment, and engineering know-how. In the year ahead, there will be unusual opportunities for ideas that generate improved living and working conditions for agricultural industries—through improved applications of electrical energy and wider use of electrical devices and controls.

**Structures and Environment.** The research, design, sale, and construction of specialized structures for farm use—crop and equipment storage units, processing centers, complete "climate controlled" units for maximum plant and animal production, farm homes and utility



Dairy cows with similar daily energy requirements are fed automatically as a group by the dairy feeding system at the University of Illinois Dairy Science Farm. The ration is assembled automatically from the various storage bins and silos, weighed, and transported to each of five separate feed bunks.

buildings. The trend is toward "mechanized" farm buildings, engineered with materials handling equipment for automatic handling and processing from raw agricultural materials to marketable products, including the disposal of waste materials. Dramatic developments are anticipated in this area as quickly as creative Agricultural Engineers put new scientific information into practical applications.

**Food Engineering.** The application of basic engineering and the knowledge of biological materials in design, research,

manufacture, sale, service, and management of equipment required in the processing and handling of food products. This includes canning, roasting, drying, sterilizing, freezing, and packaging of food products and the design of food processing plants, waste disposal facilities and the automation of plant operations. The food processing industries employ large numbers of engineers; opportunities for development of new processes and equipment offer exciting challenges.

## Job market encouraging

by Dean D. R. Operman, Director of Engineering Placement

The good news for engineers these days and for the rest of the country as well, is that the big recession has passed its low point and the economy is gradually improving. All of the government indicators attest to this fact and activity in the Placement Office confirms these trends. If inflation continues unchecked, it could have a dampening effect on hiring activity and cause some pessimism to set in, but this is not considered too likely during spring semester 1976.

Regardless of economic conditions, one thing is certain: retirements, resignations, and other turnovers will continue in the field of engineering, so that replacements will be necessary even though some industries may not be expanding in 1976. This, coupled with no increase in engineering B. S. degree graduates, means that industry will not pass up the opportunity to add talented young engineers to their work force during 1976.

The energy problem will be a strong factor in the 1976 engineering market since the petroleum industry will be expanding all phases of their operation in an effort to increase production. Industries concerned

with nuclear power generation will also be expanding in an effort to meet increased demands. An interesting report, recently released by the National Science Foundation, estimates that 125,000 engineers will be needed over the next 15 years if we are to reduce our dependence on foreign energy sources to 9 percent of our total consumption. This is an average of 8,333 engineers per year just to work in the energy field. When one considers that the number of B. S. degrees awarded annually is dropping to just slightly above 30,000, it appears that approximately a quarter of our B. S. degree production will be used to combat the energy crisis.

Many other indicators also point to a reasonably good market for engineers during 1976. Companies that have requested interview dates in the Placement Office for the spring semester are running at the same rate as one year ago, or perhaps a little better. A number of companies have scheduled dates to return to campus that have been absent for the past year or two and also a number of new companies have been added to the list. Companies cancelling their spring interview dates have been reduced

considerably from a year ago, and is currently running at about one-third of the cancellation rate twelve months ago. There has been strong demand for co-op students during the fall semester, and co-op offers have been approximately double that of one year ago. When all of these factors are taken together it seems that engineering jobs will be more plentiful than one year ago.

Engineering salaries have continued to climb throughout the recession that we have been experiencing for the last year and one-half. It appears that the salaries for the mid-year graduates for the semester just ended will be up approximately \$60 over one year ago. This is approximately 5½ percent which is quite respectable for the state of the economy. A recent survey of 631 employers indicated that they expected to increase their hiring by at least 2 percent over last year's hiring which means that the pressure to increase salaries will still be evident in the months to come.

This same survey shows that these 631 plan to hire over 15,000 engineers during the coming year, nearly half of all B. S. degrees to be granted. On the other hand, non-

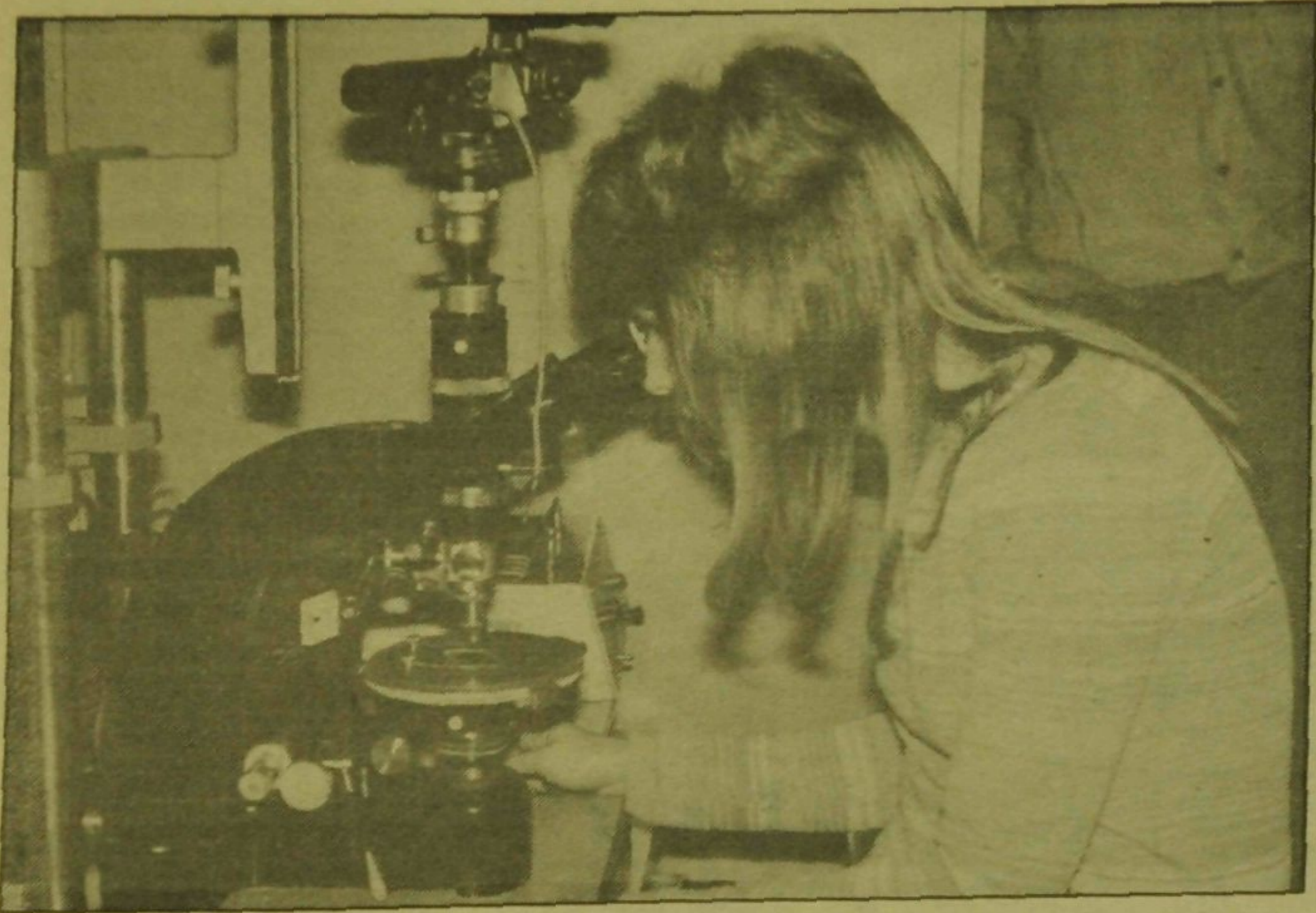
technical degree needs are expected to drop by 12 percent at the bachelor's level, 25 percent at the master's level, and 42 percent at the Ph. D. level.

There is little doubt that engineers will be in far more demand than graduates of social science and humanities programs. The anticipated need of these companies for 15,400 degrees next year is a significant fraction of all engineering degrees to be granted. On the other hand, the anticipated positions for students in the humanities and social sciences comprise only about 4 percent of the total baccalaureate degrees expected to be granted in those curricula. However, these statistics are not sufficient reason to enter engineering if a student's aptitudes point toward the social sciences and humanities.

If you follow the course of 1974 engineering graduates, the picture is somewhat less optimistic. There were some layoffs in the automotive, semiconductor and electronics industries. These did not reach "crisis" proportions by any means, but it did mean that recent engineers with little experience found themselves looking

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# CERAMIC ENGINEERING



Debra Monday, a graduate of Collinsville H.S., studies the micro-structure of an archaeological specimen.

## J.E.T.S. active

by David C. O'Bryant, State Director, JETS

The Junior Engineering Technical Society (JETS) is a nonprofit educational organization founded in 1950 with national headquarters at the United Engineering Center in New York. The primary activity of the society is to sponsor an extracurricular program for secondary school students; that is, those in grades 9 through 12 who are interested in engineering, science, and technology. These activities are designed to give the student a preview of careers in a wide range of professional engineering and scientific fields. The idea is to provide the student with an opportunity to apply classroom theories in the actual development, design, and construction of technical projects, papers, or individual research, with the assistance of a high school faculty member and professional engineering advisors from the various engineering disciplines. It is felt that this type of acquaintance with professional men and women and the experience gained from actual work while still in high school will enable the student to better determine his interests and capabilities for selecting a lifetime career in engineering.

JETS participation and activities center around JETS chapters during the school year. The organization of the JETS chapter is very similar to that of any other high school interest group. A number of students who have an interest in the field of engineering gather together under the sponsorship of a teacher and one or several local interested engineers who act as engineering advisers. The chapter meets at the members' convenience to investigate everything they can about engineering. The necessary professional education, work opportunities, and various fields of practice are looked into. The meetings usually include lectures, experiments, tours, and films on any appropriate subject which the group wishes to cover. Through the chapter, students have an opportunity to meet engineers and

find out firsthand exactly what is done within the profession itself.

In high school the student is not, in general, exposed to engineering. His teachers, counselors, and administrative officials are mostly products of a college of education. Very few, if any, have any contact with engineering. A student who is considering a career in that field will be faced with a patent lack of engineering guidance.

The public cannot expect teachers to know about every career and every profession. Engineering, because of its multidisciplinary and multi-interest practice, is one of the few professions rarely well understood or known by the non-practitioners. A means of remedying this lack of "know how" is provided by JETS.

JETS provides a vehicle through which a high school student can investigate the engineering profession prior to committing himself to a college education.

JETS operates through a chapter or club either within the high school program or as an extracurricular activity. Through the efforts of interested engineers, educators, parents, and students, the program has grown so that it now has chapters operating in over 100 high schools in the State of Illinois.

JETS has been most effective in helping students to decide what area of engineering they wish to pursue. At the same time, it has helped to call engineering to the attention of many students who have not considered the possibility of a career in this broad disciplinary area. Some students also determine, through activity in a JETS chapter, that their interest in engineering is not as true as they believed it to be.

Support for JETS comes from many sources. The Colleges of Engineering help through their faculty working with the students or administering state and regional offices. Professional engineers cooperate in every way they can. Organizations such as the Illinois Society of Professional Engineers with its many local chapters are

by M.K. Ferber

When I graduated from high school, I was definitely interested in an engineering career. However, I did not know what particular field to choose. I was a bit reluctant to attend a four year institution because I had heard rumors that freshmen were treated more like numbers than individuals. Likewise, many were supposedly "weeded out" by intentionally difficult courses in an attempt to allow only the top few to remain in college. For these reasons, I decided to attend a junior college and enroll in a pre-engineering program. I also hoped this would give me time to choose a particular field.

In two years it was time to transfer. I had decided that I wanted to go the University of Illinois. However, I was still uncertain of what specific engineering area to enter. Previously, I heard a talk on ceramic engineering. I must admit that, at first, I thought that such engineers were doomed to make toilets or ashtrays the rest of their lives. It did not seem to be a very glamorous occupation. However, the more I heard, the more I realized that ceramic engineering was a vital field.

I decided to give ceramic engineering a try. Fortunately, I found that I had made a wise decision. In fact, all my previous fears about college (more specifically, the U. of I.) were completely unjustified. For example, in all of my ceramic courses, the student-teacher relationships were fairly good. Most professors made an attempt to learn the first names of each of their students, producing a more relaxed atmosphere in the class. As a result, the students could feel more at ease in asking questions on material they did not understand. These friendly relationships also existed outside of the classroom. For example, I found that many professors were willing to discuss a class matter or some other topic of

mutual interest during their leisure time. In fact, students and professors often got together over a cold drink (not just water!) after meetings of the student branch of the American Ceramic Society.

The small size of the Ceramic Department also offered some advantages. First, it was much easier for the professors to give time to their students who were having trouble understanding course material. Being a transfer student, I often found it was necessary to discuss such problems with my instructors. I might also add that they were usually very willing to give their time and attention. This was also true in laboratories. In one particular instance, a professor willingly stayed after lab hours to help a friend and myself with an experiment that was giving us trouble.

The smallness of the department also made it easy for me to get to know other students. Some professors helped by introducing me to other people. In any case, this was especially important to me since I was a transfer student and really did not know anyone.

Presently, I am a senior in Ceramic Engineering. I hope that my story has not led the reader to the conclusion that ceramic engineering is easy. On the contrary, I have found that it is a difficult curriculum. Furthermore, the professors do not pamper the students but hand the responsibility for learning completely to them. However, the instructors are generally concerned with the individual student and, thus, are willing to give guidance (answering questions, handling problems, etc.) at almost any time.

If you are interested in ceramic engineering, I highly recommend that you visit our department. I am positive that you will find that the faculty and staff of the ceramic department are very helpful.



John Bukowski (left), from East Richland H.S., and Larry Taylor, from Conant H.S., demonstrate the strength of ceramic materials by puncturing 3/8 inch steel plates with spark plug insulators.

strong backers of JETS. Industry helps by giving financial support, and opening plants to tours. Many of their engineers also contribute with their time in chapter activities.

JETS also sponsors the National Engineering Aptitude Search (NEAS), an engineering aptitude test that is open to students in grades 9 through 12. The test is given once a year. It is suggested that a student who feels he may be interested in engineering take the test early in his high school program in order that he may

make correct academic choices which will enable him to enroll in a college of engineering. Each year hundreds of students take the test in various testing centers across the state. The test serves not only to let the student know whether he has an aptitude for engineering or not, but also it identifies those students who are interested in engineering, and early identification is important for good engineering guidance.

The third major activity of

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# CHEMICAL ENGINEERING



Chemical reactions are demonstrated at an earlier Open House by the Chemical Engineering Department.

By R.C. Alkire

Chemical engineers provide chemicals for the use of mankind. They are involved in all phases of producing chemicals on a large scale and in an economical manner. Chemical engineers do the research, development, production, and marketing for many products including plastics, fertilizer, petroleum products and drugs. In addition to production, the chemical engineer's ability to separate chemicals on a large scale has led to many processes such as wastewater treatment, desalination, freeze-drying, coal gasification and liquefaction, petroleum refining and medical applications such as the artificial kidney.

The production and processing of chemicals requires knowledge of reactor design, automatic process control, heat transfer, mass

transfer, methods of separation of chemicals, fluid flow, and economics. These topics, which are the backbone of a chemical engineer's training, are based on a foundation of chemistry, mathematics and physics.

Today's chemical engineers are facing challenges in a variety of fields. Central among these is the problem of making more efficient usage of natural resources, including fossil fuels. New processes for use of coal, for winning chemicals from the ocean, and for containment of environmental detriments, for example, fall naturally into the realm of chemical engineering. By directing attention toward the body as a chemical system, chemical engineers are deeply involved in medical problems and health care delivery systems.

## Educational Affairs Committee

by Jim Smith

The Educational Affairs Committee of Engineering Council is the engineering student body's main channel of communication with the college administration. Formed in December 1971, EAC was charged with the following responsibilities: (1.) To act as an input into the administration office in regards to areas of student interest. (2.) To be of beneficial assistance to the college in reviewing and evaluating proposals. (3.) To provide a source of information to Engineering Council and the Student-Faculty Senate. (4.) To always be cognizant of the concerns of the engineering student body.

EAC has expanded its role by instituting its own programs. An Engineering Familiarization Program was set up in which

engineering students visit an industrial facility for several days and observe the actual practice of engineering. Mini-Courses were established for the semester break to give students "practical" courses such as welding, small engine repair, sheet metal work, and machine shop. These two programs have been accepted very well in the short time that they have been in existence. EAC now meets with Dean Drucker, the Head of the College of Engineering, to discuss topics as "What should be the university's role as a research institute and as a teaching institute?" and "What should a student get out of a college education?" EAC is also working with the Engineering Placement Office to provide more summer jobs for engineering students, and preparing an engineering information pamphlet which the

Committee hopes to publish next year.

While working on these projects, EAC has not neglected its original responsibilities. The Committee has conducted surveys on the interest in an engineering-economics degree. Changes are being made in Math 345 due to a report by EAC to the College Policy and Development Committee. Each year EAC gathers ideas about Engineering 100 from freshmen and forwards these ideas to the Dean's Office. EAC is often asked to make suggestions for programs that are being instituted or changed.

## Chemistry, too!

The Chemistry Department provides a basic chemical science course for all students in the

College of Engineering, many of whom go on to advanced courses in physical, inorganic and analytical chemistry. Detailed knowledge of the structure and behavior of matter at the atomic and molecular scale is deemed necessary to engineers engaged in adapting macroscopic matter to the world's needs.

In 1976 the department is encouraging students to invite their high school chemistry teachers to the Engineering Open House, at which time they can meet with university chemistry faculty and, obtain a picture of what they are preparing university-bound students for, and discuss problems students are having at the high school-university transition. It is planned to have a high school-university faculty meeting on Saturday, March 6, from 10-12 A.M., with the rest of the day free to visit the Open House with student hosts.

## campus scout



by G.P. Labedz

I'd be willing to bet my laminated bamboo Post Versalog that the rest of this special Engineering Open House publication is just loaded with articles by deans, department heads and honor society chairpersons proclaiming the virtues of an engineering education: it's a good school, it's a good school, and besides, it's a good school.

Figuring that you'll have had your fill of this party-line baloney by the time you get to this column, I'm going to try to take you past the realm of having your uncle Barney pat you on the head at Christmas time, saying, "Oh, yes, Illinois. Good school for engineering" and expose you to what it is like to be an engineering student and actually live here.

The first thing you ought to be wary of is Engineering Open House. The official word is that EOH is set up so the people of the state of Illinois can view just what's going on in Big U

engineering. (Note to the uninitiated: "Big U" is a nickname given to this place by students, and can only be fully appreciated by the poor suckers who try to survive school here.) I have a personal theory that the people of the state of Illinois don't give two dry husks of a cornstalk what goes on here. Actually, EOH is just a move to parade all the neatest toys on campus before the wide and admiring eyes of visiting high-schoolers. Yes, kids (and parents), you are being recruited. It's a fact of life that University appropriations are closely tied to enrollment—I'll let you extrapolate the rest.

Of course what they don't tell you is that much of what you will be seeing is senior and graduate work, and unless you are smarter than most, getting there means several years of calculations, tough classes, and a heavy dose of the inside of your room.

One reason you'll see a lot of the inside of your room is that engineering is basically a participation sport, and you're going to have a lot of problems to do. While many students in other colleges have come to expect a short first class day, this is not so in the college of engineering. The teacher will enter the classroom, deliver a 10 minute speech, and start writing

like he is trying to put chalk companies out of business.

The speech typically goes like this: In hobbles Clyde Rule, ageing but brilliant professor, and says, "There will be three hour exams and a final in this course. Problem sets will be due every day. For tomorrow, work every problem in the book. If you have questions, I will give you the grader's phone number, but I wouldn't count on finding him, because he wants nothing to do with you." (Note: If this is physics 106, 107 or 108, the teacher will at this time inform the kids in the back of the room they will need binoculars.) "By the way, just so you won't think that I'm a nice guy, the grading in this course will be merciless."

Grinding through a rough curriculum with a lot of intelligent competition has its benefits, however. For instance, if you're not a drunk by the time you reach junior year, you know you never will be.

And then there's that dreaded disease that boggles the mind, cramps the stomach and frequently makes you break into a cold sweat—Computer Science 101.

This course typically takes twice as much time as any other course, which is about six times as much as you'd like it to. The exams are long and cover the most trivial

junk ever conceived by a vengeance-crazed teaching assistant. For example: "42. If the computer is performing a nested do-loop and in the third execution you slam it in the side with a 22 pound salami, will it: (a) Belch; (b) Demand a recount in the 1960 presidential election; (c) Begin printing the Torah in Hebrew?" And they get worse.

Last but not least on the serious side we have the Great Illinois Divide, that is, Green Street. Students from engineering (on the north side), and students from the University's other 11 colleges (on the south side), know equal amounts about each other, that is, nothing. Engineers tend to think other students are lazy bums who "waste" time on the liberal arts, and other students have a tendency to think engineers are cold hearted creeps who sleep with their calculators. If you should decide to come to school here, don't be a victim of this appalling ignorance. Get across Green Street for more than just to cash a check at the Union.

If you don't take advantage of the many ideas and people bursting from every corner of this, one of the country's largest Universities, then in four years when they hand you a B.S., that's just what your education will be.

# CIVIL ENGINEERING

Civil engineering is as old as civilized life, yet it is as modern as space travel or nuclear power. So, what does a civil engineer do? He may be a planner, a designer, a builder, a researcher, a plant operator, a teacher, or an administrator. Functioning in one or more of these capacities, he may have shared in the creation of any of the numerous notable civil engineering structures, or he may have had the principal responsibility for the entire project. In any case, from conception through construction, the project was the result of the combined efforts of many hands and minds. Regardless of how small or large a part he may have had in it, the civil engineer can look at the completed project and take great pride in being able to say to himself, "I had a share in that."

The practice of engineering, including civil engineering, involves knowledge of the mathematical and natural sciences—chemistry, physics, and general science. These studies usually begin in high school and continue throughout college, to provide the technical base upon which a career in civil engineering is built. A civil engineer works closely with many other professional and technical people, and their products frequently have a profound influence on the lives of people. As a consequence a civil engineer must also study in the humanities and the social sciences—sociology, political science, history, psychology, and economics, for example.

This general description of civil engineering indicates that this profession must include a large number of technical specialists. The most common areas of civil engineering specialization are briefly described in the following paragraphs. However, it must be emphasized that, while civil engineers develop competence in a specialty, they generally do not work alone, but as a part of a team.

Construction engineers manage and direct the construction operation. Manpower, materials, and equipment are analyzed with respect to the job to be done. The proper quantity of each is carefully determined and ordered so that it is available at the appropriate time and place. These civil engineers are experts in many areas because they deal with the different aspects of civil engineering. They know the capabilities of man, materials, and machinery, and they can translate the details of design specifications into an operation such as drilling deep into the ground for foun-

dations, or placing the cable over the saddle at the top of a suspension bridge tower.

**Construction materials**—Civil Engineers are often responsible for specifying, designing and manufacturing the materials with which they build their structures. Studies in construction materials are intended to make the structural, transportation, and foundation engineers aware of the fundamental properties of the materials with which they work. Topics such as the physics and chemistry of metals, ceramics, and polymers are studied in preparation for work in this area. They provide a basis upon which the behavior of structural steel, asphalt, concrete and other materials can be considered.

**Environmental engineers** have taken an increasingly important part in the affairs of the world in recent years, because of the problems of air pollution, water pollution and solid wastes. Their work is concerned with these areas of civil engineering. Environmental engineers design, build, and operate water systems that purify water for drinking, recreational purposes, and industrial uses. They also provide treatment plants that render industrial and human wastes free from pollutants and devise air purification processes to solve man's health problems. Many environmental engineers have made a career of research and study to solve the problems of living with an expanding population as well as with the problems of man's existence on other planets.

**Geotechnical engineers** are those whose special interests are in soil mechanics and foundation engineering. They utilize soil and rock as engineering materials in the design of earth and rock filled dams, levees, tunnels, braced excavations, and foundations for all types of structures.

**Hydraulic and hydrologic engineering** are closely related because hydraulics is concerned with the engineering properties of fluids, while hydrology is concerned with the distribution of fluids. The design of channels, dams, pipelines, and other structures to carry or make use of water is the concern of the hydraulic engineers and the hydrologist. Hydrology deals with the manner in which precipitation drains on and below the ground surface. It is concerned, for example, with the determination of the required capacity of a dam for flood control or with the required



Students and shop personnel in Civil Engineering are casting concrete conduits that will be stressed to test tensile strength.

capacity of a city storm drainage system. Hydraulic engineering deals with the mechanics of the flow of water and the adaptation of this knowledge to practical problems. Hydraulics uses the information developed from a hydrologic analysis, for instance, to determine the type and size of a spillway for a dam, or the size, shape, and capacity of a channel in an irrigation system.

**Ocean engineering** deals with the planning, design, analysis and construction of structures and systems in the oceans. These include structures and systems for the recovery of oil and gas under the continental shelf or deep in the ocean, undersea pipelines or tunnels, mooring and berthing facilities, harbors and waterfront facilities, and beach protection structures.

**Photogrammetric and geodetic engineering** are the two most advanced fields of surveying. They advance our knowledge of the earth and of outer space by developing new and highly accurate surveying techniques. Instruments used by

mine distance, direction, difference of elevation, and relative position. Without surveying there could be no orderly determination of the physical characteristics of a project site, no intelligent basis for design, and no means for translating the engineering drawings into an airport, a dam, or a highway.

**Structural engineering** involves the design and erection of industrial buildings, subways, tunnels, dams, skyscrapers, stadiums, hotels, bridges, office buildings, nuclear power plants, airports, and other types of facilities. The civil engineer concerns himself with the design of these structures so that they will have the required strength to serve their intended purpose. He selects the best materials to use such as wood, concrete, steel, aluminum, or one of the newer construction materials developed from a glass or petroleum base.

The structural engineer is confronted first with the task of designing a structure and then with supervising its construction to insure that it is properly and safely built. Many factors are considered in the design phase of a structure that apply to its safety, economy, function and appearance. These include the selection of the geometric form of the structure, the materials of which it will be made, the loads and forces that will act on it, the shapes and sizes of its many elements, and the effects of temperature changes, storms, and earthquakes on it.

**Systems engineering** deals with "an integrated assembly of interacting components designed to perform jointly a predetermined purpose or group of related purposes." Such assemblies of interacting elements are inherent in civil engineering projects. For example, a river control system may involve dams, hydroelectric

con't on page 7

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Our computer has been coming up with snap decisions ever since someone dropped a rubber band into it.

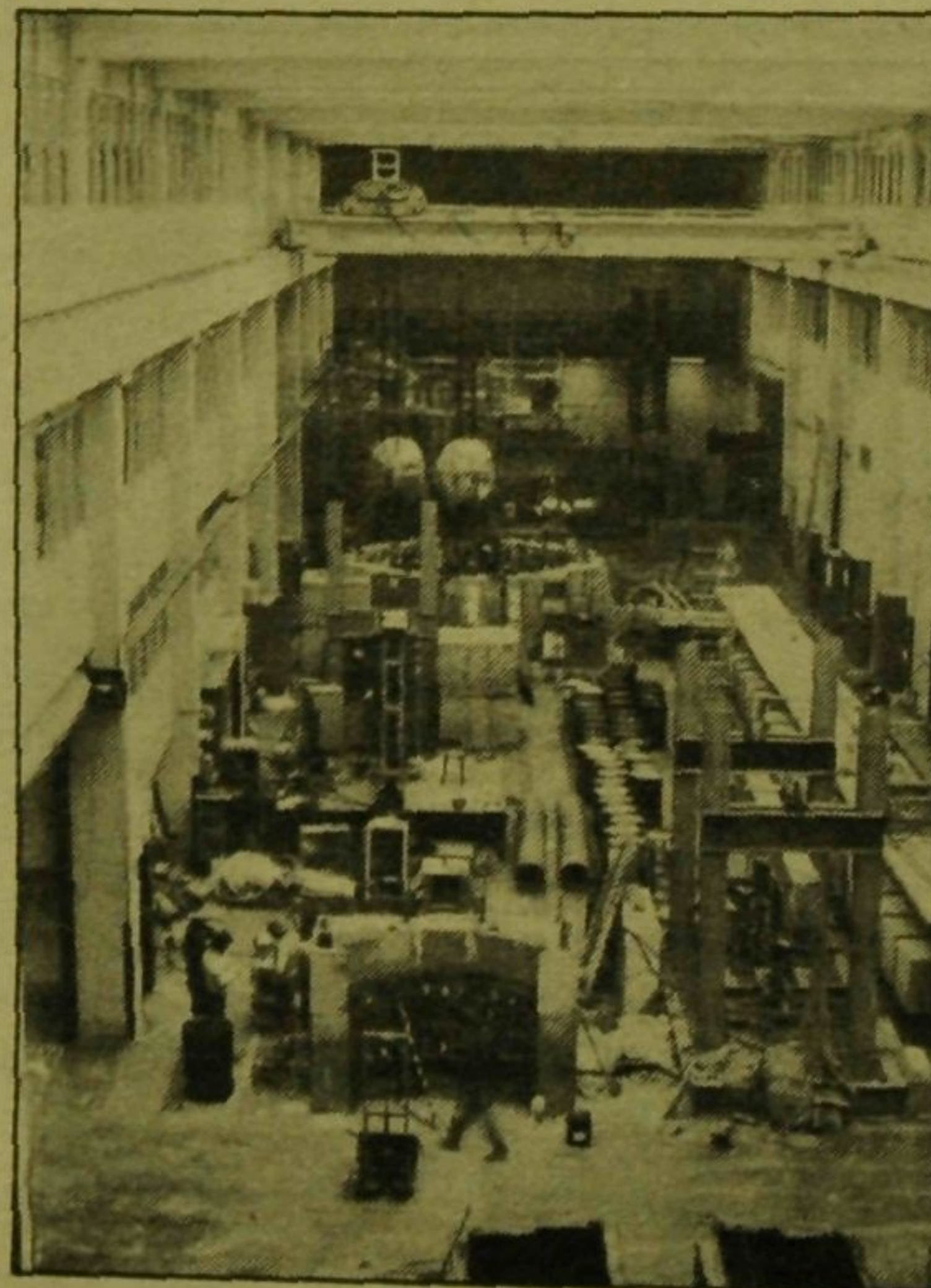
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Wrong Stone—"My husband didn't leave a bit of insurance." "Then where did you get that gorgeous diamond ring?"

"Well, he left \$1,000 for a casket and \$5,000 for a stone. This is the stone."

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Freshman Petroleum Engineer—"Isn't it great how these service station people know just where to set up their pumps to get gas?"



Here is the crane bay in the civil Engineering Building where students and faculty test concrete structures.

civil engineers in this area are capable of "pin-pointing" locations on the moon, or on the opposite side of the world. Satellites traveling in outer space can survey an area to determine with great accuracy the heights of mountains, widths and lengths of ground formations, types of soil or rock or the density of the atmosphere. The rapid development in the space and oceanographic sciences and the increasing importance of global navigation and communications have created interesting and challenging problems in this area.

Surveying principles and techniques are utilized in all phases of construction in order to deter-



Visitors receive a first-hand view of the crane bay.

# COMPUTER SCIENCE

by H.G. Friedman, Jr.

One would have to be a hermit in order to avoid having one's life affected by computers. Our bank accounts, department store charge accounts, and income tax records are kept by computers. Production in our factories, stock control in our warehouses, and movement of our shipping is monitored by computers. The little electronic calculators which are now available for as little as \$20 are the offspring of computer technology. Some of the great social issues of our day, such as privacy and spying problems, are problems precisely because the computer makes certain kinds of information easy to store, disseminate, and use. And it has become a standard joke to say that such-and-such an error was made by a computer, so there's nothing that can be done about it!

And yet, the ease with which that last kind of statement goes unchallenged demonstrates how little most people know about computers. The average person is

overawed by a computer. This awe is misplaced. A computer is nothing more—or less—than a big, fast, mindless, adding machine. It can do three things: it can add (and therefore it can also subtract, multiply, divide, take square roots, calculate trigonometric functions, etc.); it can make simple, two-way ("binary") decisions, such as whether a number is positive or negative, zero or non-zero, etc.; and it can move information around. This is the limit of a computer's ability. The key to its apparent intelligence is its speed. A modern computer can add two numbers in about one millionth of a second. Therefore, it can carry out a very large number of instructions in the time it takes a human to move his hand from one button to the next.

Because of its speed, a computer is used in a different way than an ordinary calculator. Since the computer cannot wait for its instructions to be entered, one by one, as a calculation proceeds, it is



Using the keypunch is a common pastime with all Computer Science Students. They punch their programs on cards and submit them to be run on the computer.

necessary to write down all of the instructions for a calculation before starting the computer on the calculation. If the progress of the calculation depends on some intermediate result, the instructions to test this intermediate result must be included, along with complete information on what to do for each possible outcome of the test. This set of instructions is a "computer program," and the person who writes the program is called a "computer programmer."

It is the responsibility of the programmer to make sure, by suitable testing, that the program is error-free; the computer will execute nonsense instructions just as fast and just as precisely and just as tirelessly as it would sensible instructions, since it cannot tell the difference. It is important to keep in mind that any apparent intelligence a computer demonstrates is the intelligence of the human being who programmed it. And any "mistake" the computer makes is the mistake of the person who programmed it or the person using the program.

Computer programming is one part—perhaps the best known part—of the field of computer science. The term "computer science" includes the design of the machine itself and its peripheral devices (the "hardware"), the programs which run on it ("software"), the methods which are built into such programs (e.g., "numerical analysis"), and the theory behind all this. Students in computer science at the University of Illinois are asked to take courses in each of these areas, so as to acquire a broad knowledge of the field. Sometimes, this results in a surprise, as a student discovers a previously unsuspected interest in one of these areas. Whatever a student's interest, there are suitable jobs available.

The Bureau of Labor Statistics projects (Bulletin 1826, 1974) that employment in computer occupations will grow from about 765,000 in 1970 to almost a million by 1980, a rate of increase higher than the rate projected for total employment in the same period. The same report predicts that computer personnel will require more and better training than has been necessary in the past, as hardware and software become more complex, and applications become more varied.

What sort of jobs await college graduates of computer science? Some graduates will go into the

computer industry itself. Here, one might work for a manufacturer, either designing computer hardware, designing and writing operating systems (the "master programs" which make the computer easy to use), or creating application programs for use in business, science, etc. One might write programs for a firm which specializes in writing and selling complete packages of programs. Or, one might work for a commercial computer center, which provides computer services to a variety of clients, and needs application programmers of various sorts—business, statistical, scientific—depending on its clientele.

Outside of the computer industry proper, there are a wide variety of industries which require computer personnel to staff their own computers. The Bureau of Labor Statistics mentions in particular manufacturing, wholesale and retail trade, finance, insurance, and real estate as industries hiring large numbers of computer personnel. There is a growing need in such industries for personnel with training, not only in computer programming, but also in the overall analysis of systems of hardware and software to meet particular needs. For example, in the retail sales industry, "point of sale" data entry terminals (which function both as cash registers and as input devices to a computer) are becoming increasingly common, leading to systems in which the computer can process a whole day's transactions in the evening after closing and have the day's report on the manager's desk the next morning.

The College of Engineering at the University of Illinois at Urbana-Champaign was one of the first U.S. engineering schools to grant a degree to a woman (in architecture in 1878). But women's enrollment languished until the late sixties; by 1970 there were still only 60 women undergraduates enrolled.

But a campaign of active encouragement began to show results. By 1973, the college was one of only five U.S. schools of engineering with an undergraduate enrollment of 100 or more women. This fall, the college posted a record enrollment of 285 undergraduate women, nearly 7½ percent of the total undergraduate enrollment.



Visitors at last year's open house using computer terminals at the Digital Computer Laboratory.

## CIVIL from page 6

power stations, irrigation canals, and pipeline networks to cities in order to conserve, regulate, harness, and use water in times of drought and flood. Systems engineers require a philosophy and viewpoint that enables them to take wide overall views of the problems involved by posing and answering questions relating to the relative importance of each component of the system.

Systems engineers are confronted with problems of great magnitude. Typical problems are the development of entire regional areas, flood control of river systems, redevelopment of cities, and the design of continental transportation networks. In such vast undertakings, civil engineers are literally building the nation, and opportunities exist everywhere.

Transportation engineering is a branch of civil engineering that deals with the economical and efficient movement of people and goods. Transportation engineers work to meet the transportation needs of society while satisfying environmental and energy constraints. Transportation engineers are responsible for the planning, analysis, design, construction, maintenance and safe operation of all types of terminals and facilities used by automobiles, trucks, airplanes, railroads, ships and other forms of transportation.

Water resources engineering

deals primarily with the conservative use of the world's water resources to satisfy in an orderly, equitable, and efficient manner the increasing industrial, agricultural, and human requirements for water. To achieve this objective requires not only technical competence in the collection, control, and handling of water, but also consideration of the economic, social, political and financial aspects of the management of our water supplies on local, regional, national and international levels.

Teaching and research appeals to numerous engineers. It is a career that is highly rewarding from the personal satisfaction gained in teaching others to do something worthwhile. The engineering teacher also devotes time to research activities, and often becomes engaged in private consulting practice. Work of this type is encouraged to advance the knowledge of engineering technology through research and study. Through consulting work practical experience can be gained and shared with engineering students in the classroom. Teachers as well as all civil engineers are encouraged to write professional papers and become engaged in professional society activities. It is through these endeavors that new techniques and theories are communicated and contribute to a rewarding career.

# ELECTRICAL ENGINEERING



Electrical Engineering student David Iseman, graduate at Streater Township H.S., works on a laboratory experiment.

Electrical engineering deals with an amazing variety of things. A few comments may illustrate this. The amount of electrical power of interest may be as small as that detected by a sensitive radio receiver (about  $10^{-15}$  watt) or as large as that furnished by a modern electric generating station (about  $10^9$  watts). The frequency of electrical signals ranges from zero (direct current) to more than  $10^{16}$  Hertz (above the optically observable frequencies). Although a field as large and as diverse as EE has an abundance of opportunities and challenges, these are most easily seen in the context of the various subdivisions of the field.

The paragraphs which follow attempt to describe the opportunities and challenges of Electrical Engineering in the context of an arbitrary grouping of the various facets of EE. New opportunities and challenges may be expected to present themselves in the near future which may seem to fit awkwardly, if at all, in the context implied here.

Professional engineering in electrical power involves many aspects including: manufacturers of electrical power equipment, electric utilities, consulting engineers and builders, govern-

ment agencies, and consumers of large amounts of electrical energy.

The energy crisis and environmental limitations have created unusual and formidable challenges to this area. These challenges are being met by men and women who are industrious, imaginative, ambitious, and talented. Power engineers work on problems concerned with the development of new energy sources including the direct conversions of heat energy to electricity, extra-high-voltage a-c and d-c overhead transmission, high-voltage underground transmission, new concepts for power distribution, practical ways of storing and recovering large amounts of energy, new concepts for system reliability and protection, and improved methods of operating and controlling the large interconnected power network of the United States.

Today's computers span a broad range. Multimillion dollar scientific and business computers provide rapid computation and information processing. Microprocessor circuits with thousands of devices on a quarter inch square of silicon, which sell for three dollars to four hundred dollars, are used in hand-held

calculators, automobiles, kitchen blenders, and industrial plant controllers. Our sophisticated society has a seemingly boundless need for the computation, information, and control which can be provided only by the computer.

The related disciplines of communication and control system engineering have an impact on all aspects of modern life. Examples of communication systems are familiar to everyone—radio, television, the world-wide telephone network, communication satellites, optical communication systems, radar, and sonar. Much of the character of today's world is determined by the ability to communicate nearly instantaneously over vast distances. Similarly, control systems are found everywhere about us. Guidance and control of aircraft and spacecraft, control of complex industrial processes such as oil refining and steelmaking, and automatic regulation of voltage and frequency within narrow limits in large power networks are typical control system examples. Moreover, principles of feedback control and system theory are increasingly important in widely divergent fields such as economics,

one sixteenth sq. in. Already the price of these devices has decreased by an order of magnitude and the performance has increased by an order of magnitude. Never before has so much computational power been available at such a low cost. Without integrated circuit technology the complex signal processing and logic functions implemented with these circuits would be impossible.

The impact of the integrated circuit in the consumer market (e.g., calculators, watches, cameras, and electronic games) has been substantial but the impact in the areas of instrumentation, communications, and control have been just as great. For example, automotive manufacturers are planning electronic systems to monitor and control engine performance for improved efficiency and lower emissions plus control of many other functions. It is clear that the capability for realizing thousands of complex functions on a small silicon chip will create a significant demand for electronic engineers in the future to (a) design integrated circuits to implement sophisticated functions, (b) evaluate and test the designs,



Here a visitor prepares to fire Electrical Engineering's magnetic cannon at a bucket across the room.

## Junior college program

Most Illinois Community Colleges have a pre-engineering program comprised of two years of study. Normally, students completing such programs can transfer to the College of Engineering UIUC and complete their engineering studies in two additional years.

The Engineering College has recently coordinated these programs with 26 Illinois Community Colleges to insure no loss of transfer credit. Ten more Community Colleges are in the process of completing coordination of engineering programs. An individual brochure has been developed for each of these Community Colleges, listing the courses to be taken in the first two years and the requirements which would remain after transfer. Copies of these brochures are available in 207 Engineering Hall or through the Community College.

Normally, transfer students are expected to have 60 or more semester hours of credit prior to transfer and a grade point average of 3.25 or better on a 5.0 scale. In the first two years of pre-

engineering study, students are urged to complete their basic sequences in mathematics through calculus, general physics, general chemistry, English composition, and computer programming (Fortran).

The Community Colleges which have completed a coordination with the College of Engineering UIUC are: Belleville Area College, Black Hawk College, City Colleges of Chicago, College of DuPage, College of Lake County, Danville Junior College, Elgin Community College, Highland Community College, Illinois Central College, Illinois Valley Community College, Joliet Junior College, Kankakee Community College, Kaskaskia College, Lewis & Clark Community College, Lincoln Trail College, Oakton Community College, Olney Central College, Prairie State College, Rock Valley College, Sauk Valley College, Spoon River College, Springfield College in Illinois, Thornton Community College, Triton College, Waubesa Community College, William Rainey Harper College.

business, biology, and political science.

The revolution currently taking place in the electronics industry, induced by the integrated circuit, is indeed rapidly moving and achieving amazing results. The integrated circuit was born when solid-state technology was combined with photolithographic technology. The basic building block of the integrated circuit is the transistor which can be used as an amplifier, switch, diode, storage cell, or load. By means of photolithographic techniques the size of the transistor can occupy as little as 1 sq. mil (1 mil equals .001 in.) on a silicon wafer; literally thousands of transistors can be interconnected on a  $\frac{1}{4}$  inch x  $\frac{1}{4}$  inch silicon wafer. It is precisely this technology that has led to the development of powerful hand-held calculators, electronic watches, sophisticated cameras, and small integrated circuit amplifiers which often cost less than the price of a resistor.

In spite of all these products, the revolution is only in its infancy. Three years ago a complete computer system (the microprocessor) was built on a silicon wafer in an area of less than

and perhaps most importantly (c) have sufficient understanding of integrated circuits to be able to design systems which improve the quality of our life.

The pocket calculator, the digital watch, electronic ignition, transistor radios, lasers. The tremendous advances in all of these areas have been spurred by developments in the general area of electrical engineering called physical electronics. This area concerns itself with the development of the electronic devices that generate, detect, transmit, and amplify electrical energy and information. Based on a strong knowledge of physics, optics, electromagnetic theory and properties of materials, tremendous strides have been made in the development of transistors, integrated circuits, light emitting diodes (LED's) and lasers. The effect of such advances has revolutionized the electronics industry and continues to play a dominant role in the electrical engineering profession.

The electrical engineer that is prepared to work in this field can be assured of working in an exciting and fast moving field.

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# GENERAL ENGINEERING

The General Engineering program at the University of Illinois has two outstanding features. One is the emphasis on engineering design, and the other is the flexibility available through the secondary field of concentration to satisfy a wide range of engineering related career goals. The education of the general engineer is broader in scope and more diversified in subject matter than the traditional curricula in engineering generally allow. The graduate in General Engineering is well grounded for professional practice and has employment opportunities over a wide range of career positions.

Students in General Engineering obtain a firm background in the basic sciences such as chemistry, physics and mathematics before moving on to take a substantial amount of work in the engineering sciences including statics, dynamics, strength of materials, fluids, thermodynamics and basic electronics. The core of the program is engineering design which includes seven courses beginning in the freshman year and culminating in the last semester project design. The design courses are articulated to cover the basic concepts and methodologies in structural design, machine design and control systems. A unique feature of the design sequence is the design project in the senior year, whereby the student works on actual design problems directly from industry. Normally two or three students work as a team with a faculty advisor and a company design engineer. This capstone experience provides a student with an opportunity to gain an early insight into the real world of engineering.

The engineer is sought after as a project leader, and on a broader scale as an executive interpreting technical considerations to other engineers or to management. A recent survey has shown that engineers now fill more than 45 percent of the top positions for three hundred of the largest manufacturing companies in the United States. The general engineer is sought by a variety of companies, both large and small; graduates of General Engineering have been successful in manufacturing, chemical or process industry, public utilities, and a wide range of government departments.

General engineers fill positions from administrators to project designers, supervisors, and group leaders in research or production. They also serve as technical sales representatives, technical service representatives, directors of publications or public relations units, and in other posts requiring both technical knowledge and ability to deal effectively with ideas in relation to people.

One of the unique features of the General Engineering curriculum is the blending of design procedures from several fields, especially those required for structures and machine elements. This is accomplished through a sequence of seven project design courses. In the freshman year an introduction to design is presented; two courses in engineering analysis and a course in dynamic systems are given during the junior year; and

the series is completed with a course in component design and another in project design during the senior year.

The focal point of this design sequence is the project design course of the senior year. In this course the student has the opportunity to utilize all of his previous academic training in the solution of a real world of work engineering design problem. These design problems are carefully selected to enable the students working in teams of two and three to function as they would on the job in solving a problem. These problems are directly from industry and the student works directly with company engineers with the faculty acting as consultants.

The systems approach to problem solving is emphasized. The student must first prepare a formal definition of the problem. He then formulates various methods of solving the problem and critically evaluates each alternative. Periodic oral progress reports stimulate lively class discussion.

These sessions contribute effectively to a realistic professional design atmosphere and experience in which the physical and economic aspects of the final solution are thoroughly analyzed. Finally, the student submits a complete design ready for the draftsman and estimator, and defends his solution before members of the faculty and interested students.

Next to the emphasis on project design, the opportunity to select a secondary field of concentration is truly a unique feature of the program in General Engineering. Any meaningful career goal can be satisfied with the careful selection of a group of courses. Actually, all 21 hours of electives can be organized to take advantage of gaining a depth of understanding in the particular related field being studied.

One of the most popular secondary fields of concentration is engineering administration. The student takes courses in accounting, economics, business administration, finance and other related areas. These courses coupled with an engineering base and project design training provide an excellent background for moving into administrative positions in industry. A significant number of graduates with this education move into ownership of their own companies, while others move into top administrative positions in large companies. The combination of being able to function as an engineer along with being able to understand the economics of the business world makes the General Engineering graduate highly sought after by industry.

The engineering marketing secondary field includes courses in marketing, industrial selling, market research, consumer behavior, communications and other courses related to marketing. The General Engineering graduate with this background is able to move into industry where he is able to function as the engineering liaison between the client and the manufacturing company. In this role the graduate becomes in-

involved in assisting the design of the company's product to meet the needs of the client.

In some cases this involves minor modifications of the basic product. In other cases it will require a complete systems design. The combination of the marketing background and the solid engineering project design capability prepares the graduate to do well as a sales engineer.

The energy shortage facing the nation today makes it obvious that there is a real need for technically trained personnel to work in the mining and oil industries. For those students interested in this field the General Engineering curriculum has been modified to provide a background in the fundamental concepts of geology, mining and earth sciences. The principal interdisciplinary fields between geology and engineering include geophysical exploration and development of natural deposits such as petroleum, minerals and water; soil and soil mechanics studies; location and development of deep-storage facilities, and mine shafts.

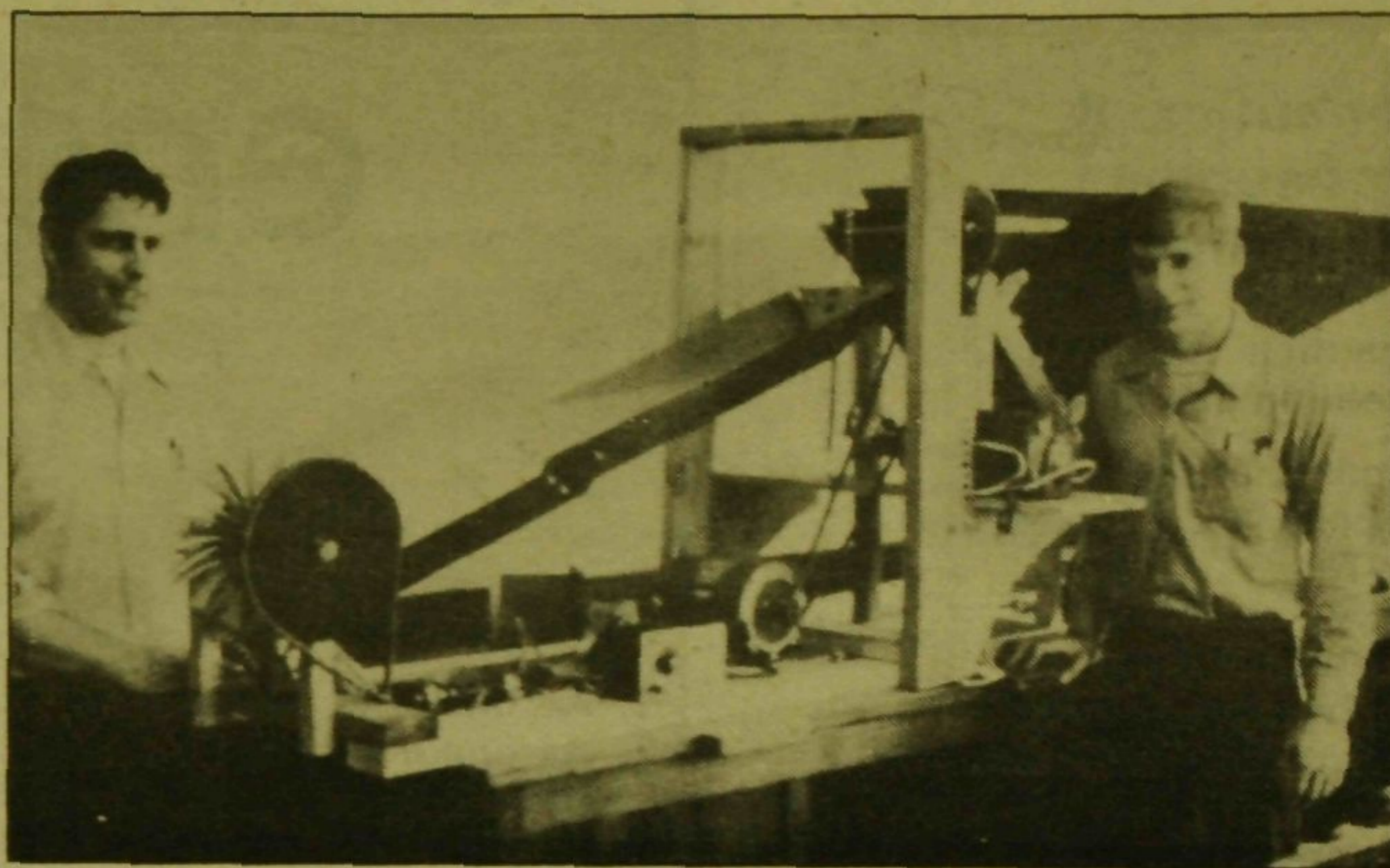
Mining engineering specifically can be applied to system design for economical extraction and removal of coal and minerals, either below or on the surface. Cooperative projects with landscape architects and planners for surface and strip mines or gravel pits can insure economical recovery and eventual usability of sites for residential and recreational purposes, once mineral removal has been completed. Such planning is now one of the modern methods being ex-

plored to rescue and protect large and potentially valuable properties from permanent loss and blight, while improving the amenities of the total community.

Also, the General Engineering curriculum establishes a foundation of courses from which the student can approach graduate study in geology, in mining or petroleum engineering, or in civil engineering, especially in such subfields as soil mechanics or hydrology.

One of the most rapidly developing engineering fields in recent years has been in the area of environmental quality. This field requires a broad understanding of engineering with a related knowledge in such areas as human ecology, environmental biology, water quality, air quality, aquatic ecology, and a host of others. By carefully selecting from a list of approved courses the student in General Engineering can prepare to go on for further graduate work or go to work in industry or a government agency.

General Engineering graduates with the environmental quality secondary field have been in demand by both Federal and State Environmental Protection Agencies as well as by municipalities. Many industries are rapidly expanding their efforts in improving the environmental quality of their operations. Other companies are involved in designing and fabricating various systems used in improving environmental quality. It is a relatively new field with many opportunities.



Art Snyder (left) and Dennis Sadowski demonstrate a bottle unscrambler they built for Eli Lilly. This project is an example of the type of work students do in General Engineering's senior design project.

## Top-Ranked Schools by Profession\*

Engineering	Fraction of** Choices
1. Massachusetts Institute of Technology	119/131
2. University of Illinois	84/131
2. Stanford University	84/131
4. University of California, Berkeley	67/131
5. California Institute of Technology	62/131
6. University of Michigan	58/131
7. Purdue University	42/131
8. Georgia Institute of Technology	14/131
8. University of Wisconsin	14/131

\* Reprinted from Change magazine

\*\* The number of Deans of Engineering who selected the indicated school as one of the five best in the U.S. divided by the number of Deans responding.



revolutions in engineering

## Exhibits

### Aeronautical & Astronautical Engineering

#### Aeronautical & Astronautical Engineering Laboratory

Windmill Energy  
Low Speed Wind Tunnel  
Shock Tube  
Rocketry  
Interplanetary Tour  
NASA Research Exhibit  
Paper Airplanes  
Sound Chamber  
Magnetohydrodynamics  
Revolutions in Flight Movies  
Ramjet  
Solar Energy  
Structures  
Aerodynamic Phenomena  
Fluid Flow Table  
Atmospheric Circulation  
Analog Computer

### Agricultural Engineering

#### Agricultural Engineering Building Agricultural Engineering Research Laboratory

Power and Machinery  
Farm Structures  
Soil Water  
Processing

### Ceramic Engineering

#### Ceramic Engineering Building

Porcelain Enameling  
Strength Demonstration  
Glass  
Bioceramics  
Sintering of Ceramics  
Electrical Ceramics  
Refractories  
Crystallography  
Archeological Ceramics  
Nuclear Ceramics  
Solar Energy

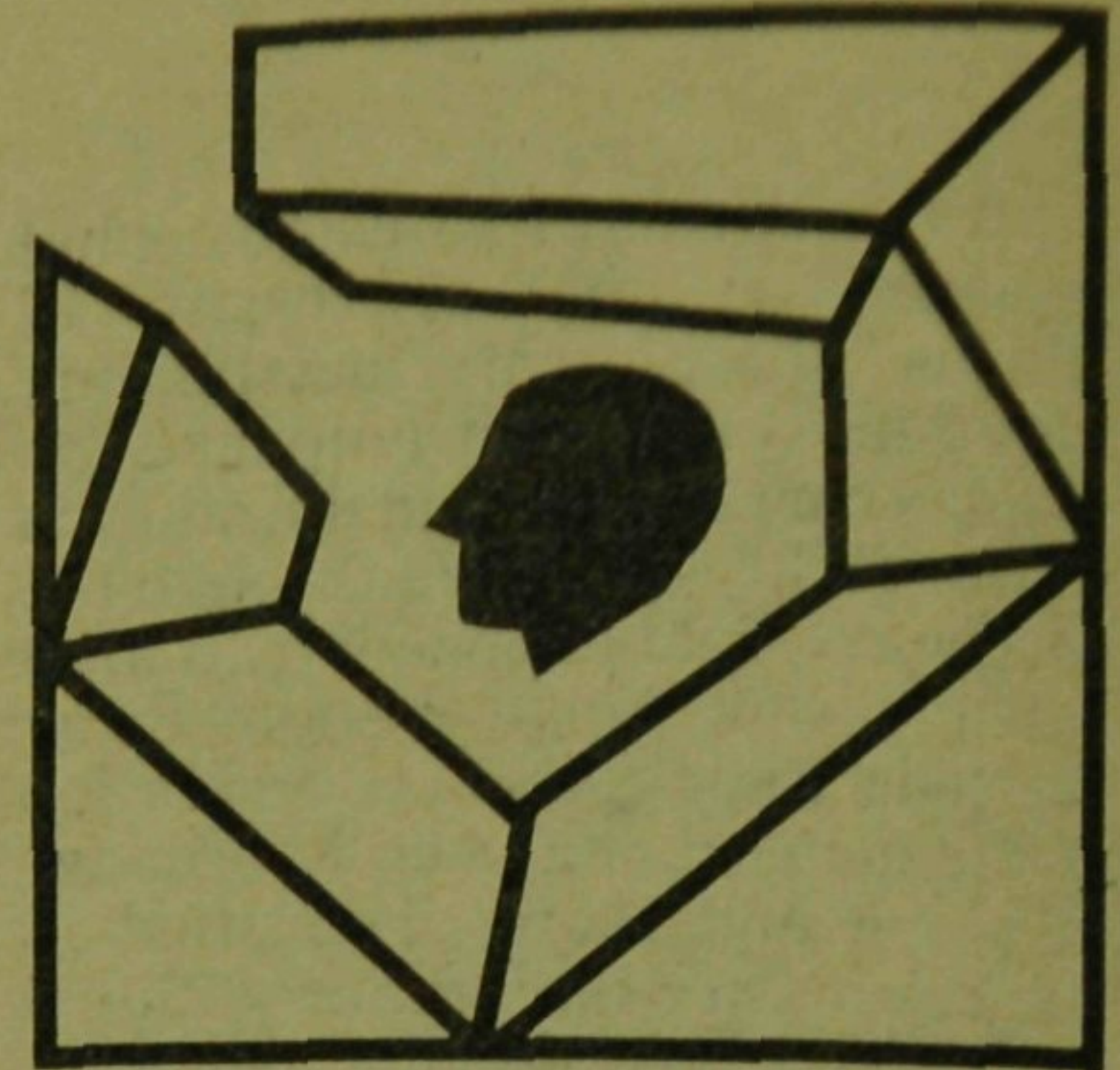
### Chemical Engineering

#### Noyes Laboratory Roger Adams Laboratory

### Civil Engineering

Model Span Contest/crane bay/Civil Engineering Building  
Civil Engineering Exhibits/crane bay  
Transportation Engineering Exhibits-/Fourth floor Engineering Hall  
Locomotive & Amtrack cars/siding near Abbot Power Plant

# revolutions in engineering

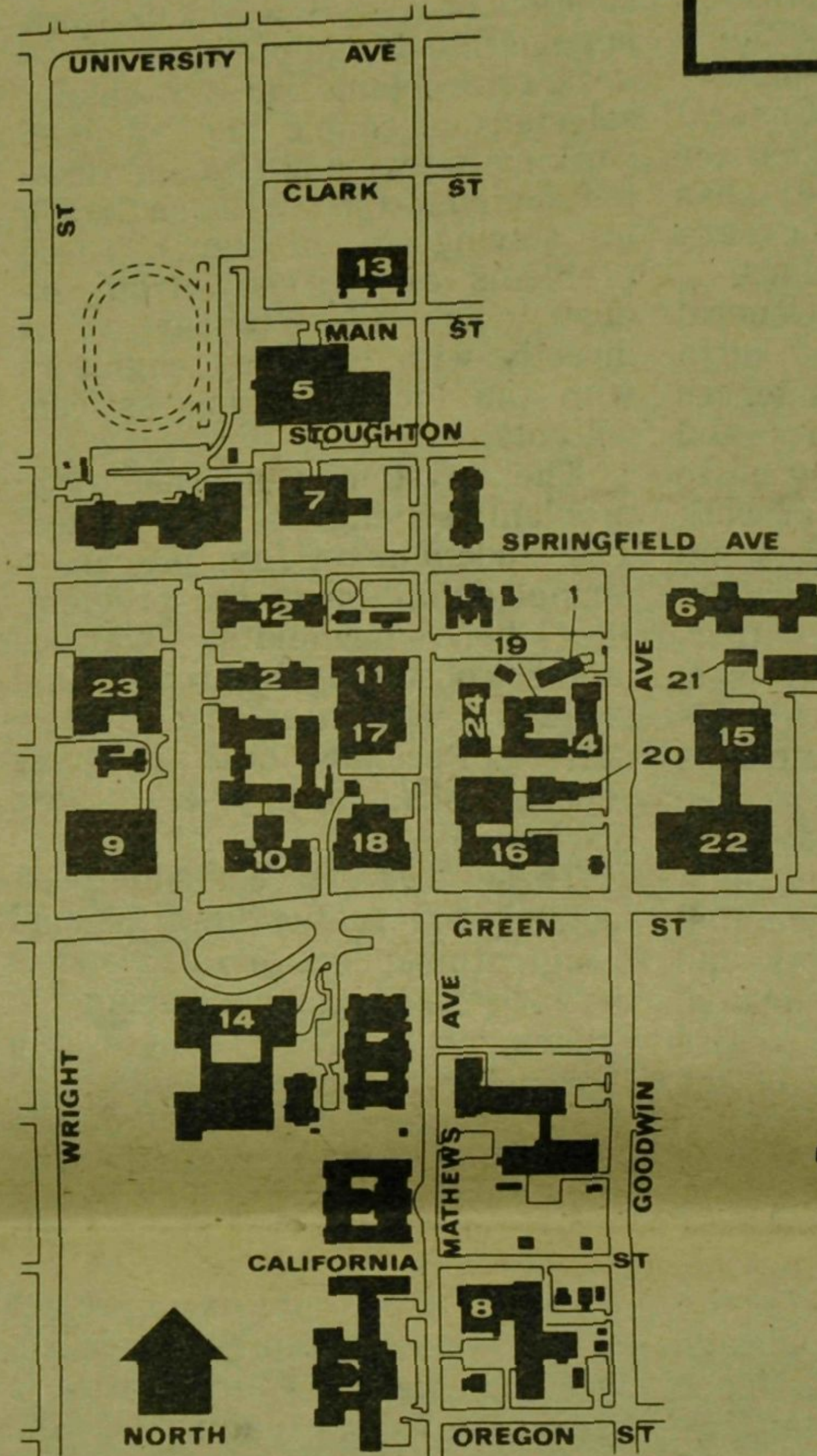


#### MAP KEY

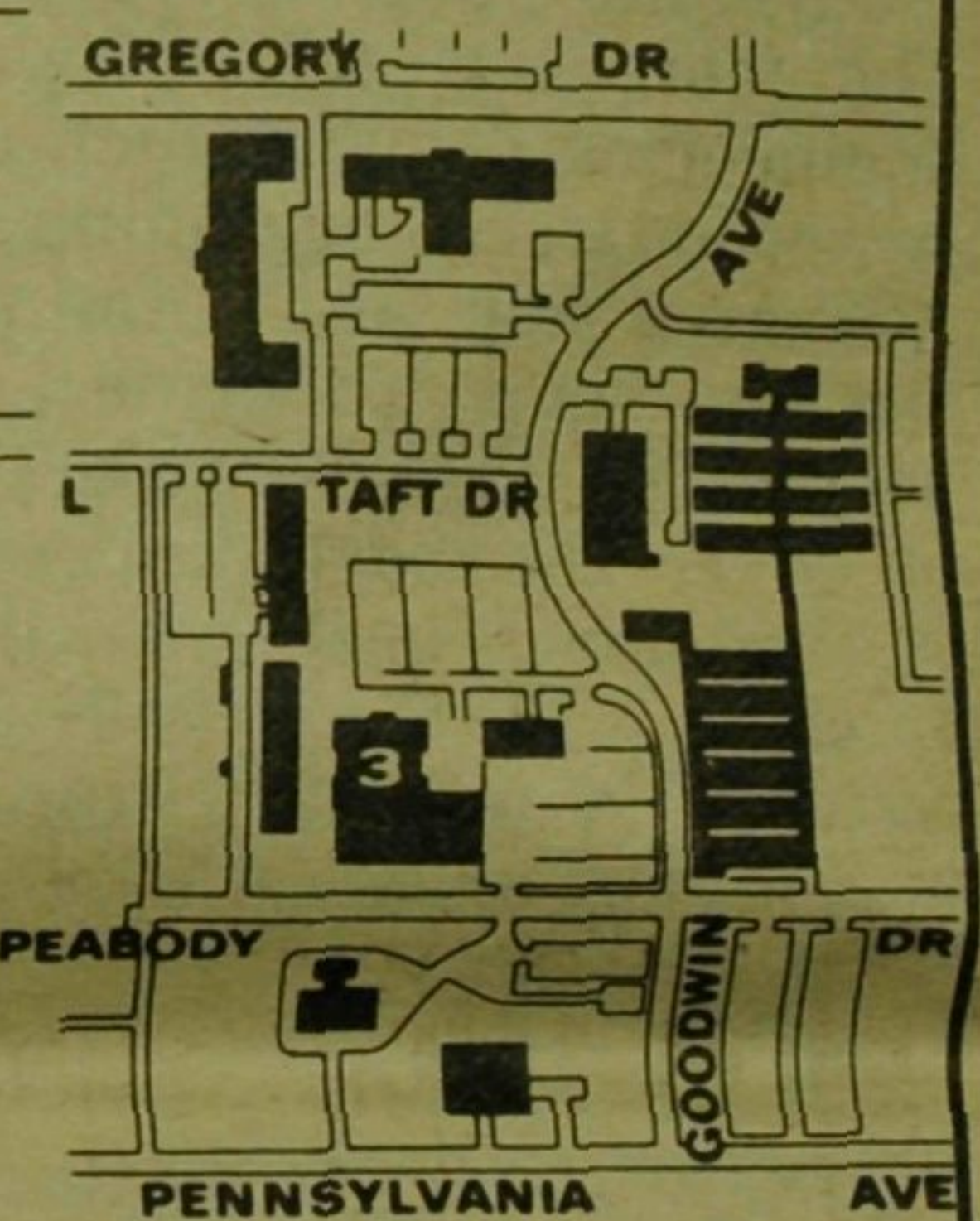
1. Aeronautical Lab A
2. Aeronautical Lab B
3. Agricultural Eng Bldg
4. Ceramics Bldg
5. Civil Eng Bldg
6. Coorinated Science Lab
7. Digital Computer Lab
8. East Chemistry Bldg
9. Electrical Eng Bldg
10. Engineering Hall
11. Engineering Research Lab
12. Foundry
13. Hydrosystems Lab
14. Illini Union
15. Materials Research Lab
16. Mechanical Eng Bldg
17. Mechanical Eng Lab
18. Mining and Metallurgy Bldg
19. Nuclear Eng Lab
20. Nuclear Radiation Lab
21. Nuclear Reactor Lab
22. Physics Bldg
23. Talbot Lab
24. Transportation Bldg

#### EMERGENCY NUMBERS

Emergency Police or Ambulance 1-1-1  
University Police 333-1212  
University Fire Dept. 333-2424  
First Aid 333-2700  
There will also be a First Aid Station in Engineering Hall.



#### Engineering Campus map



To reach area shown in insert go south on Goodwin Ave

### Computer Science

#### Digital Computer Laboratory

Hardware Exhibits  
Digitized Speech  
Logical Devices  
Computer Graphics  
Tours

### Electrical Engineering

#### Electrical Engineering Building

Engineering for Energy, Environment, and Economy (Illinois Power)  
"Dyna-T-Ac" (Motorola) Portable Telephone System  
Auto Electronics (Delco)  
Digitally Tuned AM Receiver  
Speech Divider-Multiplier  
One Armed Bandit  
Magnetic Cannon  
Magnetic Skillet  
S-Parameter Design  
Theremin (Electronic Musical Instrument)  
Jacob's Ladder & Tesla Coil  
Electrostatics  
Digital Displays  
Mouse in a Maze

### General Engineering

#### Transportation Building

Design Project Models  
Balsa Wood Projects  
Wind Generated Electricity  
Solar Powered Water Heater  
Product Liability  
History of Engineering  
Law and Patents

### Mechanical and Industrial Engineering

#### Mechanical Engineering Building

Metal Pouring & Casting  
Working Models of Ingenuous Mechanisms  
Vehicle Dynamics  
Machining Processes  
Industrial Robots  
Coal Gasification Concepts  
Time-and-Motion Study  
Wankel & Other Internal Combustion Engines  
Hydrolic Analogy of High Speed Compressible Flow

### Metallurgical and Mining Engineering

#### Metallurgical and Mining Building

### Nuclear Engineering

#### Nuclear Reactor Laboratory

### Physics

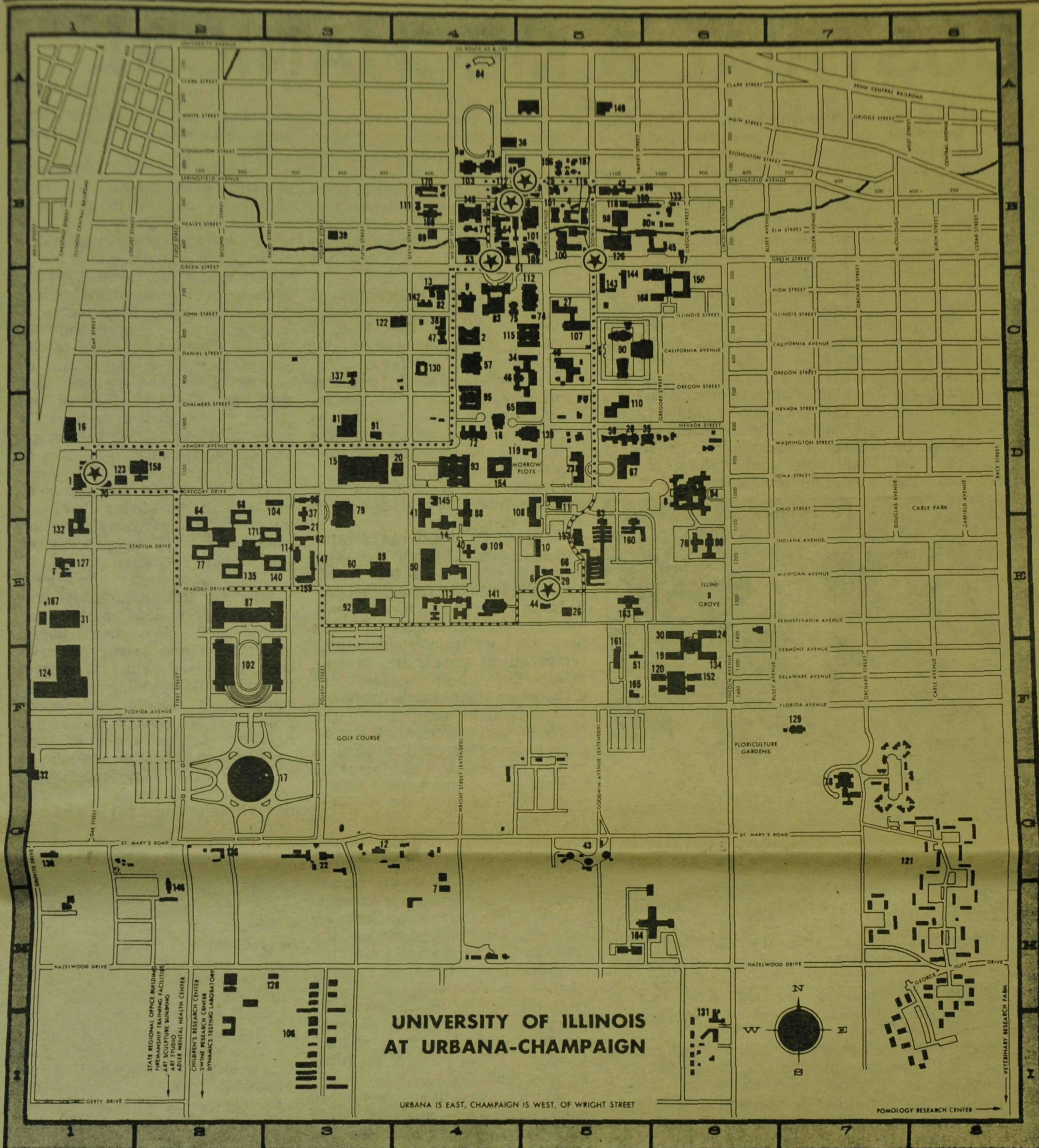
#### Physics Building

Television Transmission by Laser  
Holograms & Rainbow  
Computer  
Lectures & Demonstration  
Plant Feelings  
Floating Wire  
Plasma  
Laser Radar  
Surface Harmonics

### Theoretical and Applied Mechanics

#### Talbot Laboratory

Fluid Mechanics  
Experimental Stress Analysis  
Strength of Materials  
Dynamics  
Computer Based Materials Test System  
Fracture  
3 Million Pound Testing Machine



## ★ bus stop

1 Abbot Power Plant.....	D-1	84 Illinois Field.....	A-4	133 Environmental Research Laboratory.....	B-6
2 Administration Building.....	C-4	85 Illinois Street Residence Halls.....	C-6	134 Saunders Hall.....	F-6
3 Advanced Computation Building.....	B-5	86 Institutional Research, Bureau of.....	B-5	135 Scott Hall.....	E-2
4 Advanced Study, Center for, 912 W. Illinois St.....	C-6	87 Intramural-Physical Education Building.....	E-3	136 Sheep Barn (St. Mary's Road).....	G-2
5 Aeronautical Engineering Laboratory B.....	B-4	88 Kramert Art Museum.....	C-5	137 Sherman Hall.....	C-3
6 Aeronautical Engineering Laboratory A.....	B-5	89 Kramert Center for the Performing Arts.....	C-5	138 Small Homes Council-Building Research	G-1
7 Aeronomy Laboratory.....	B-4	90 Labor and Industrial Relations Building.....	D-3	Council Building.....	G-1
8 Agricultural Engineering Research Laboratory.....	E-5	91 Law Building.....	E-3	139 Smith Memorial Music Hall.....	D-3
9 Agricultural Engineering Research Laboratory.....	E-5	92 Lewis Faculty Center.....	C-6	140 Snyder Hall.....	E-3
10 Agricultural Service Building.....	H-4	93 Library.....	D-4	Social Work, Jane Addams Graduate School of,	C-5
11 Allen, Louisa C., Residence Hall.....	D-6	94 Lincoln Avenue Residence.....	D-6	1207 W. Oregon St.....	C-5
12 Alpha House, 1207 W. Springfield Ave.....	B-5	95 Lincoln Hall.....	D-4	Speech and Hearing Clinic, 601 E. John St.....	C-4
13 Altgeld Hall.....	C-4	96 Lundgren Hall.....	D-3	102 Stadium, Memorial.....	F-2
14 Animal Genetics Building.....	E-5	97 Mailing Center.....	B-6	State Regional Office Building.....	I-2
15 Animal Sciences Laboratory.....	D-5	98 Materials Research Laboratory.....	B-5	State Universities Retirement System,	I-2
16 Animal Science Barns (St. Mary's Road).....	G-3	99 McKinley Hospital.....	E-6	30 E. Gerty Dr.....	I-2
17 Arcade Building.....	C-4	100 Mechanical Engineering Building.....	B-5	Stenographic Service, 1203 W. Oregon St.....	C-5
18 Architecture Building.....	E-4	101 Mechanical Engineering Laboratory.....	B-5	Stiven House, 708 S. Mathews Ave.....	C-5
19 Armory.....	D-3	102 Memorial Stadium.....	F-2	141 Stock Judging Pavilion.....	E-4
20 Armory Avenue Warehouse.....	D-1	103 Men's Old Gymnasium.....	B-4	142 String Annex, 1205 W. Nevada St.....	D-5
21 Art Sculpture Building.....	I-2	104 Men's Residence Halls Post Office and Snack Bar.....	D-3	143 Student Services Building.....	C-4
22 Art Studio.....	I-2	105 Metallurgy and Mining Building.....	B-5	144 Student-Staff Apartments, Goodwin Avenue.....	C-5
23 Assembly Hall.....	G-2	106 Moorman Animal Breeding Research Farm.....	I-3	145 Surveying Building.....	D-4
24 Auditorium.....	D-4	107 Morrow Plots.....	C-5	146 Swine Barn (South First Street Road).....	I-2
25 Babcock Hall.....	F-6	108 Motion Picture Production Center.....	B-4	Swine Research Center.....	I-2
26 Band Building.....	D-4	109 Mumford Hall.....	D-5	147 Taft Hall.....	E-3
27 Barton Hall.....	E-3	110 Music Building.....	D-5	148 Talbot, Arthur Newell, Laboratory.....	B-4
28 Beef Cattle Barn (St. Mary's Road).....	G-3	111 National Council of Teachers of English.....	B-4	149 Television Building.....	A-5
29 Beaver Hall—Home Economics.....	D-5	112 Natural History Building.....	C-5	Theory Annex, 608 S. Mathews Ave.....	C-5
30 Biological Control Laboratory.....	H-1	113 Natural Resources Building.....	E-4	150 Townsend Hall.....	B-5
31 Blaisdell Hall.....	E-6	114 Noble Hall.....	E-3	151 Transportation Building.....	B-5
32 Botany Annex and Greenhouse.....	B-5	115 Noyes, William Albert, Laboratory of Chemistry.....	C-5	152 Trelease Hall.....	F-6
33 Burnside Research Laboratory.....	E-5	116 Nuclear Engineering Laboratory.....	B-5	153 Turner, Jonathan Baldwin, Hall.....	E-5
34 Burrill Hall.....	C-5	117 Nuclear Radiation Laboratory (Cyclotron).....	B-5	154 Undergraduate Library.....	B-4
35 Busby, Mary E., Residence Hall.....	D-5	118 Nuclear Reactor Laboratory.....	B-5	University Civil Service System of Illinois,	C-5
36 Car Pool Garage.....	E-5	119 Observatory.....	D-5	1205 W. California Ave.....	C-5
37 Carr Hall.....	E-1	120 Oglesby Hall.....	F-6	156 University High School.....	B-5
38 Central Food Stores Building.....	F-1	121 Orchard Apartments.....	G-8	157 University High School Gymnasium.....	B-5
39 Central Receiving Warehouse.....	B-5	122 Parking Structure.....	C-4	158 University Press Building.....	B-2
40 Ceramics Building.....	C-5	Peabody Drive Residence Halls.....	E-2	159 Van Doren Hall.....	E-3
41 Chemistry Annex.....	C-5	Personality Assessment and Group Analysis	C-4	160 Vegetable Crops Building.....	E-5
42 Child Development Laboratory—Home Economics.....	I-7	Laboratory, 907 S. Sixth St.....	E-6	161 Veterinary Clinic, Large Animal.....	F-5
43 Children's Research Center.....	A-4	Pennsylvania Avenue Residence Halls.....	E-6	162 Veterinary Medicine Building.....	E-5
44 Civil Engineering Building.....	D-3	123 Personnel Services Building.....	D-1	Veterinary Medicine Hospital and Clinic,	H-5
45 Clark Hall.....	C-4	124 Physical Plant Service Building.....	F-1	Small Animal.....	H-5
46 Coble Hall.....	C-5	125 Physical Plant Service Building Annex.....	B-5	163 Veterinary Medicine Research Laboratory.....	F-5
47 Colonel Wolfe School.....	E-4	126 Physics Building.....	B-5	Veterinary Research Farm.....	I-8
48 Commerce Annex.....	B-3	127 Physics Research Laboratory (Belatron).....	E-1	Visual Aids Service Building.....	E-1
49 Commerce Building, West.....	D-4	128 Physiology Research Laboratory.....	H-2	166 Vivarium.....	B-4
Community Planning, Bureau of.....	C-5	Pomology Research Center.....	I-8	167 Valaile Storage Building.....	E-1
50 1202 W. California Ave.....	B-5	Practice Annex, 1205 1/2 W. Nevada St.....	D-5	168 Wardall Hall.....	C-6
51 Coordinated Science Laboratory.....	G-5	129 President's House.....	F-7	169 Warehouse.....	B-5
52 Dairy Cattle Barns (St. Mary's Road).....	G-5	130 Psychology Building.....	C-4	170 Water Resources Building.....	B-4
53 Dairy Manufactures Building.....	C-6	131 Purebred Dairy Barns (South Lincoln Avenue).....	I-6	171 Weston Hall.....	E-3
54 Daniels Hall.....	B-6	132 Rehabilitation-Education Center.....	E-1	172 Woodshop and Foundry.....	B-4
55 Davenport Hall.....	C-5	49 Roger Adams Laboratory.....	C-5	World Heritage Museum.....	D-4
56 Davenport House.....	C-4				

# INDUSTRIAL & MECHANICAL

The employment picture for mechanical and industrial engineers is bright. This can be based on the track record in these two areas plus the broad opportunities available in the job market for both the mechanical and industrial engineer. Aside from the time of a total depression, you find during slack times that it is only certain areas of the economy that suffers. Since both mechanical and industrial engineers find employment in a very broad spectrum they are not apt to have the difficulties, or "bust or boom" situations in entering the job market after obtaining their educational degree.

Using information supplied by the American Institute of Industrial Engineers and the

the storage points by materials handling devices. The Industrial Engineer must determine what materials handling devices are necessary in order to bring the right part to the right place so that the assembly line will not bog down. He must also maintain a proper balance of manpower on the assembly line.

In the manufacturing of appliances, Industrial Engineers help decide future demand for appliances, when these appliances should be produced in order to supply the demand, the proper number of parts to be kept on hand in order to insure uninterrupted production, the economical purchase of these parts, pricing of appliances, and staffing of personnel for production.

physics and chemistry courses are similar to the ones he makes. Because the solution may not be seen in a single step or two, the Mechanical Engineer performs an "analysis" - steps of reasoning with each step based on the conclusions of the preceding one. So mark down calculation or analysis as another characteristic.

Next, let us enter into a somewhat more subtle concept called "modeling." This kind of modeling is done in the mind and is not the kind that uses clay or wood. For instance, when an engineer approaches a problem that does not yield immediately to past experience, he tries to formulate a description in his mind and on paper, and perhaps with the use of the language of mathematics, that explains how the real device or system works.

Suppose the nozzle on a large rocket engine is literally breaking into pieces during a test firing. First, the engineer forms a picture in his mind of the factors entering into the problem. Some of these are: the heat transfer from high temperatures gases, the eroding effects of these gases, the distribution of stresses in the nozzle wall caused by temperature differences and mechanical forces. Once he has an overall, qualitative outline formulated, he tries to calculate how much heat flows, where it flows, what the temperature differences are and where they occur. He can then answer the question in quantitative detail, "why did the nozzle fail?" So he tests the nozzle in an attempt to verify his conclusions. If there is not complete correlation between the tests and the predictions, it's back to the analysis, correct the assumptions, and calculate again. This kind of work is highly characteristic of the engineer. So mark down modeling of physical systems or devices as a characteristic of Mechanical Engineering.

So far we have mentioned calculation or analysis, and modeling that uses analysis, and we have assumed the Mechanical Engineer works with something that exists. How did that something come into being? It could have been a natural phenomenon, part of nature such as a bolt of lightning, or it could have been manmade such as a malfunctioning engine or an inadequate transportation system. Manmade things designed by engineers must be perfected or replaced by other designs created by engineers. This brings to light another aspect - the Mechanical

Engineer creates, designs and builds that which did not exist before.

For example, if the problem is to reduce exhaust emissions from automotive engines to avoid air pollution, what is the best way to go about it? A device might be added to the present engine which burns the exhaust further. A car that runs on batteries, a fuel cell or steam is another possibility. In each case, it is necessary to proceed from an idea to a general outline of the approach or device by means of experience, test and analysis. And, once the general nature of the device is established such as its potential power output, size, shape and weight, then it is necessary to select, calculate and test every nut and bolt, every grid, every piece of material. All must fit together in an integrated plan which will form the whole device. This process of sandwiching together layers of ideas, imagination, creativity, experience, testing, analysis and modeling is called "design" or "synthesis." Note that ideas, imagination and creativity have been combined with the terms analysis and modeling to accomplish a design. A design problem is open-ended. It does not have one single correct or best answer (which is often the case in analysis). There is no best mouse trap - just better ones. So, design has its own uniqueness. It connects many of the abstract characteristics of engineering directly to useful applications - the machines, the tools, the instruments, the systems, the products needed by mankind. So mark down design or synthesis as the next characteristic of Mechanical Engineering.

The Mechanical Engineer is also concerned with the needs of humanity. He deals with the physical aspects of human life and applies the mechanics of machines to the bones and muscles that characterize humans. The Mechanical Engineer is involved in life sciences as well as physical sciences - bio-engineering. He has to be concerned with the human side of problems; as how his work fits into and contributes to the needs of man beyond material considerations. He must ask - and answer - how his work can help society. And, he must answer within a framework of realistic costs. So mark down another characteristic: today's engineer applies economics, life sciences and need to contribute to the solution of socio-humanistic problems.



Students of the Mechanical Engineering department demonstrate some of their motion machines to visitors at a past Engineering Open House.

American Society of Mechanical Engineers, I can point out this breadth and the varied fields of interest open to engineers in these two disciplines.

## Industrial Engineering

The American Institute of Industrial Engineers, Inc., the national professional society of Industrial Engineers, defines the profession as follows:

"Industrial Engineering is concerned with the design, improvement, and installation of integrated systems of persons, materials and equipment. It draws upon specialized knowledge and skill in the mathematical, physical and social sciences together with the principles and methods of engineering analysis and design to specify, predict and evaluate the results to be obtained from such systems."

Let us look at a few practical examples of just how vital an Industrial Engineer is in a few selected industries.

In today's space program, the Industrial Engineer is vital in coordinating men, space vehicles, control and guidance systems and technology...all those forces needed in perfecting life support systems for other environments. In fact, coordination of the vital resources into all of the functions of a successful enterprise is one of the key responsibilities of Industrial Engineering for both today and tomorrow's way of life.

Consider the automobile assembly line and the problem of supplying such a line with thousands of parts each day. Although many of the automobile parts, both large and small, may be stored next to the assembly line within easy reach of the workers, most of them must be brought to

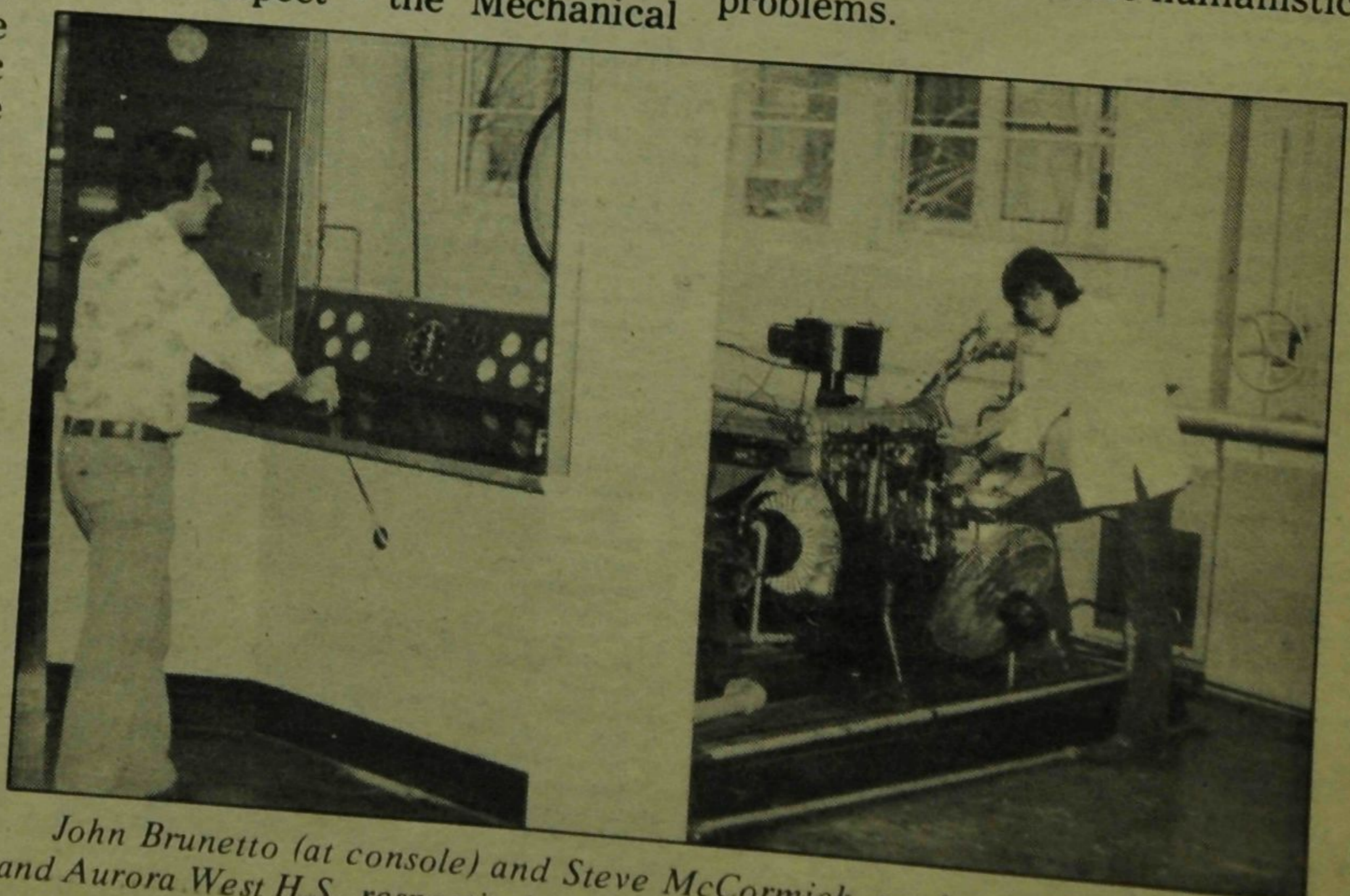
## Mechanical Engineering

Each Mechanical Engineer does something different from his colleagues, and what he is depends substantially on himself. So mark down breadth, individuality and flexibility as the first characteristic of Mechanical Engineering.

Before we illustrate in words and pictures what Mechanical Engineers are doing, let us first establish a connection with your background; namely, your high school physics course. This is not the only important course that must precede an engineering education, but we will use it for a special purpose at present. In physics you studied the subjects of mechanics, heat, electricity, light, sound and perhaps some atomic physics, so you know what these words mean. Mechanical Engineers use all of these, but their greatest emphasis is on mechanics and heat.

It should be noted that mechanics include fluids as well as solids, and the fluids inturn range from water at rest to hypersonic gases flowing around a none cone re-entering the earth's atmosphere. And heat can flow at very low temperatures such as those of liquid hydrogen or at very high temperatures in the hypersonic gases just mentioned. So mark down mechanics and heat as the technical subject areas that form the main basis for Mechanical Engineering.

Still another characteristic of the Mechanical Engineers is his use of calculation. With pen and paper, mathematics and physical laws, slide rules and computers, he calculates what a device will do before he builds it. The calculations that you do in your mathematics,



John Brunetto (at console) and Steve McCormick, graduates of Gillespie H.S. and Aurora West H.S., respectively, test a Pontiac engine.

# METALLURGY

Metallurgy is the science and technology of metals and their application in useful products. It covers a wide range of engineering practices including techniques for extracting metal from ores, the refining of metals and development of alloys used in a myriad of things used in society. Although the work can be extremely varied, most metallurgists specialize in one of

aluminum from aluminum oxide.

**Thermal refining.** Some compounds simply decompose at high temperatures producing the pure metals.

The other large area of metallurgy is called "Physical Metallurgy." In this field, methods are developed for combining pure metals into useful mixtures called alloys and techniques are found to

steel. Therefore they are often used where weight is of special importance—in aircraft, luggage, and ladders, for example.

**Reinforced metals.** Metals and alloys can be reinforced by adding strong fibers to the material before it is solidified. Copper transmission lines are often reinforced with a steel inner core to provide strength. The vanes in fan-jet engines are often reinforced with superstrong fibers.

**Bio-materials.** We are all familiar with heart valves made of plastic materials, of hip joints made of metals or ceramic materials and of metal pins and screws for holding bones together. This application of materials is exceedingly difficult because of the highly corrosive nature of most body fluids. Even so, enormous strides are being made in determining compatibility of implants with bone, flesh and the blood; with providing strength, durability, lubrication and other features important to structural implants; and with use of materials for corrective procedures (bone straightening, spinal column support and tendon replacement). All materials—plastics, metals and ceramics—hold great promise for body implants.

**Coal gasification.** The chemical reactions which accompany the gasification (or liquefaction) of coal place great demands on materials. Corrosive gas mixtures, erosion of high speed gases containing particles, and high pressures at high temperatures make this a complicated engineering process. Inserting large volumes of pulverized coal into a reactor at high temperature and high pressure is very demanding of pumps and valves. Transmissions of the resultant gas or liquid through existing pipelines poses additional problems. The problems associated with safety and efficiency of operation,

combined with long life, pose very severe materials problems which are scarcely known.

**Nuclear power.** Nuclear power plants have their own materials problems. The matter of safety, engineering reliability, efficiency of operation, long life, containment of a reactor if the core goes out of control—these all pose very severe materials problems. Fusion reactors, which generate power much in the same manner as energy is developed in the sun, has materials problems of complexity which we cannot fully fathom.

**Solar energy.** Solar energy is plentiful in most parts of the nation and its utilization in the heating of hot water and of homes and offices is largely a problem of architecture, building design and economics. The production of electricity directly from solar energy is quite another matter. Present solar generators such as those used in space missions are prohibitively costly for use on land, have very short lives, and are relatively inefficient. To produce electrical power generation directly from the sun requires enormous materials research and immense technological development.

Problems of high speed transportation, increased efficiency of jet aircraft, reliability of welded structures, safety in design and manufacture of appliances and products, substitutions for scarce materials, recycling and environmental problems, toxicity of materials—all these and more demand our attention. Materials engineers, collaborating with design engineers and economists, will have to solve these problems in the future. The field of materials study and research has enormous possibilities for bachelor's candidates, as well as for graduate students. The potential is vast and the necessity for good engineering design has never been greater.



Mike Howe, Willowbrook H.S., and Bill Jones, St. Albans H.S., West Virginia, test creep deformations in metals in the Metallurgy and Mining Department.

two main branches, extractive metallurgy or physical metallurgy.

The "extractive metallurgist" is concerned with producing metals from ores. Except for gold, silver, platinum and copper, most metals are found in nature in the form of compounds with such elements as oxygen, sulfur or carbon. To obtain the pure metal, various processes must be developed for refining these ores. The list below describes a few of the methods used in these refining operations.

**Chemical refining.** Ores can be reduced to metals by reacting with other chemicals, usually at high temperatures. An excellent example is the production of iron in a blast furnace.

**Refining by electricity.** Certain metals can be refined by using an electric current. The best example of this is the production of

fabricate useful products. Qualities such as strength, resistance to corrosion, appearance, durability, and ease of manufacture are all very important.

Here are a few of these materials and the problems involved in their use:

**High strength steels.** Steel is produced in large amounts, nearly one ton for each person in the country each year. Out of it we make tools, machines, automobiles, motors—a myriad of products. Building construction also uses a great deal of strong steel for beams. Steel for pipelines must be carefully controlled to withstand high pressures, corrosive atmospheres and temperature extremes.

**Light-weight alloys.** Alloys of aluminum, magnesium and titanium are much lighter than

## Black Engineering Student Association

by Kim Caldwell, BESA

The Black Engineering Student Association (BESA) was founded in 1971 by Rupert Graham Jr., for the purpose of establishing unity among black engineering students on the Champaign-Urbana campus of the University of Illinois. At that time, there were very few blacks enrolled in engineering at the Urbana campus, and those who were here found the academic life very rigorous. The blacks in engineering at that time needed some common ground, some means by which they could communicate effectively and help each other. Thus, the Black Engineering Student Association came into being.

The objectives of BESA center around familiarizing the black community with the many diversified aspects of engineering. BESA attempts to expose the community to engineering and at the same time to stimulate an interest in engineering. There is a lack of knowledge in the black community with regard to the extreme importance of engineering, indicated by the small number of black students who are

receiving engineering degrees. Black engineers are needed because an increase in the number of black engineers will contribute to the economic independence of the black community and also to the much needed technical expertise. This will be achieved by channeling money into the community in the form of higher salaries.

In an effort to present engineering to the black community, BESA, in cooperation with the College of Engineering, coordinates an annual program which involves inviting black high school and junior college students to the Engineering Open House. In addition, the high school and junior college students are provided with transportation to and from the Open House. The activities include a tour of the engineering campus and exhibits with BESA members serving as guides, discussions with black engineering students and alumni, and also a discussion with admissions personnel in which points about high school preparation for engineering are brought out. The purpose of this program is not one of recruiting for the University of Illinois, but



Black students attend an earlier open house as guests of BESA.

rather one of exposing the visiting student to the different fields of engineering. In the past three years, BESA has invited high schools from Chicago, East Saint Louis, Champaign-Urbana and several junior colleges in Chicago, establishing a total contact of approximately 1650 black students.

This year the program is being continued with a special effort to establish a more personal relationship with visiting students.

In addition to the Open House program, BESA coordinates other services to black students who are

currently enrolled in engineering at the University of Illinois. These include tutoring sessions, a file of old exams and notes, counseling, course and teacher evaluations, and a certain amount of exposure to summer jobs.

Also of great benefit to engineering students on this campus is Dean Paul Parker. Dean Parker is a black, half-time dean who helps coordinate many of BESA's activities.

Thus, BESA's goals are to get blacks interested in engineering, and if they should decide to major in engineering at the University of Illinois, to provide services which will aid them in obtaining an engineering degree.

For suggestions or questions contact:

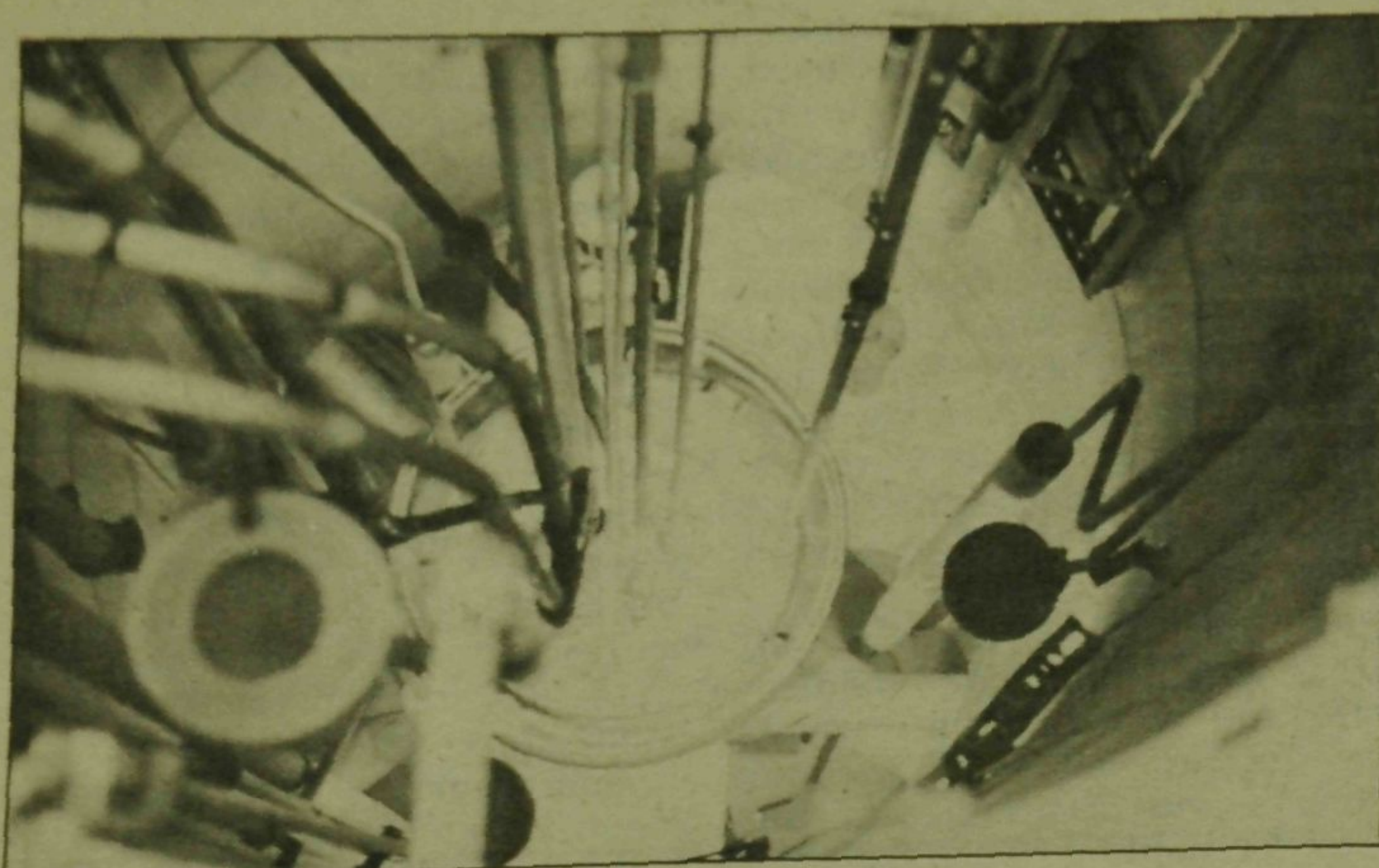
Mr. William Harris  
302 Engineering Hall  
Urbana, Illinois 61801  
(217) 333-3558

or

Dean Paul Parker  
207 Engineering Hall  
Urbana, Illinois 61801  
(217) 333-2280

# NUCLEAR ENGINEERING

## T.R.I.G.A. reactor



This is a view of the core of the Tiriga Reactor. The reactor is used for both teaching and experimental purposes.

Nuclear engineering is primarily dedicated to the operation, design and development of energy supply systems utilizing nuclear sources. Nuclear engineering also includes many other applications of nuclear technology, such as radiation protection engineering, and nuclear medicine. At the University of Illinois Nuclear Engineering Program, both fission and fusion are considered as energy sources.

The Nuclear Engineering Program at UIUC has one of the largest graduate enrollments and one of the strongest research programs in the nation. Twenty-eight faculty members are associated with the program and about 110 graduate students are enrolled. A new undergraduate curriculum has also been initiated as of Fall 1975 which currently has an enrollment of 31. The undergraduate enrollment is expected to exceed the graduate enrollment within a few years, making it one of the largest undergraduate programs in the nation.

The undergraduate curriculum is aimed at providing background in nuclear reactor operational principles and physics, the principles of reactor safety and radiation protection as well as a broad background of engineering

courses. In addition there are individual study courses wherein the student may interact with a faculty member on a particular subject matter for credit or participate in a research effort for credit.

There is an active American Nuclear Society student chapter in the Nuclear Engineering Program. Undergraduate and graduate students participate in the affairs of the chapter. The ANS student chapter participates in regional student conferences and conducts service oriented projects in the University and surrounding communities. Social events are also a portion of the ANS activities. These events include semester parties and picnics.

The Nuclear Engineering Program has a nuclear reactor which provides a valuable facility for several aspects of nuclear technology. It serves as a training facility for reactor operation and as a research tool. The Nuclear Engineering Laboratory houses subcritical assemblies and a neutron generator available for use in research efforts. A laboratory for developmental laser studies is also housed in NEL. Several other experimental research facilities associated with the Nuclear Engineering Program are located in various labs in the Engineering College.

Little known to many students on this campus is the existence of T.R.I.G.A., the University of Illinois nuclear reactor. Built in 1960, the reactor has been primarily used for research, training, and graduate student projects. The reactor is housed in a small grey brick building situated on Goodwin Avenue between the Physics Building and the Coordinated Science Laboratory.

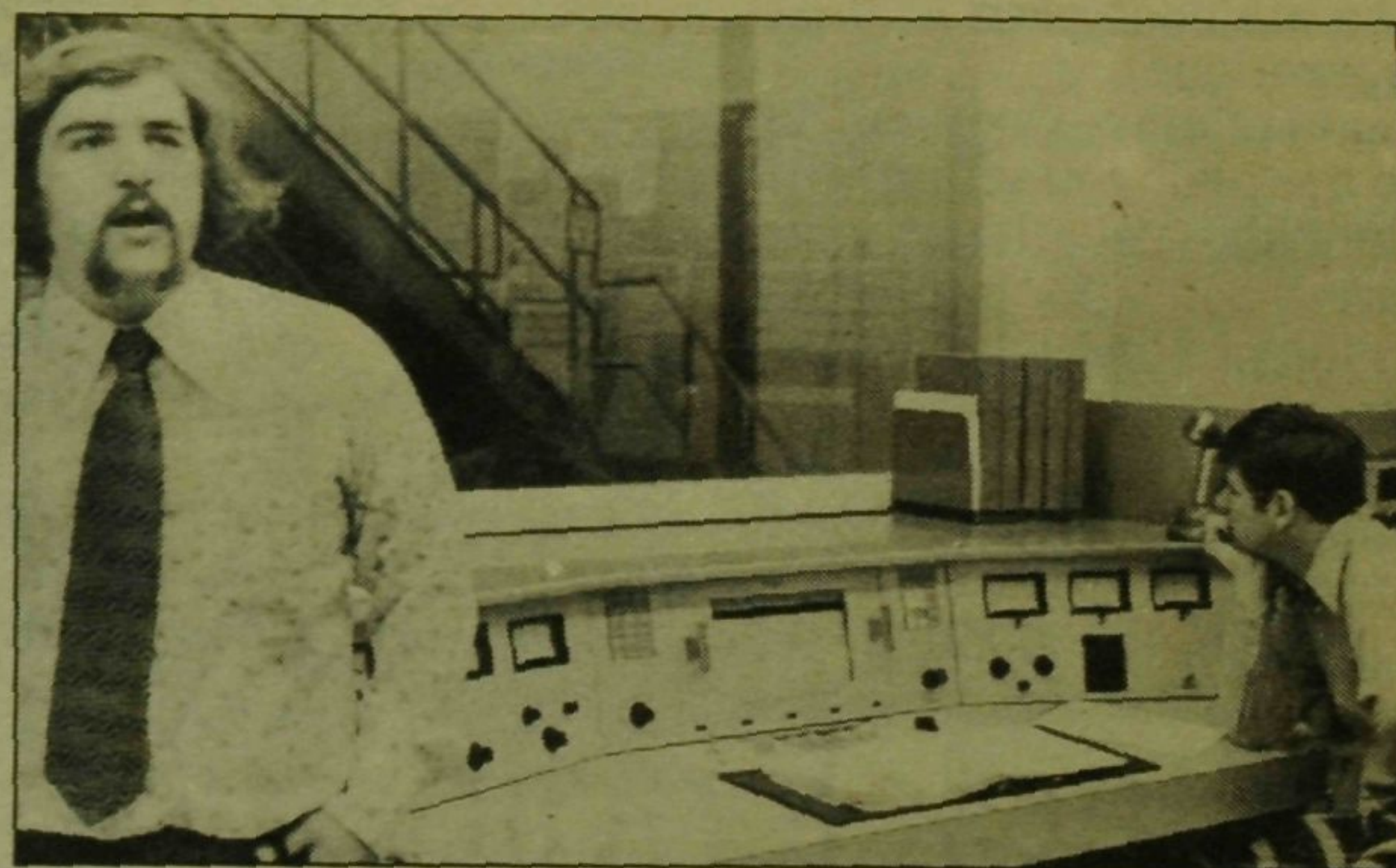
As originally designed, T.R.I.G.A. (which stands for Training, Research, Isotope production, General Atomic) was licensed for a maximum steady-state operation of 100 kilowatts. Because of improvements and modifications of fuel, core systems, cooling systems, and console design, the reactor now holds a license for steady-state power operations of up to 1,500 kilowatts and pulsing capabilities with peak powers of up to 6,000,000 kilowatts (a pulse is initiated by a sudden withdrawal of a control rod with the reactor in a supercritical condition.)

At the University of Illinois, sixty percent of the reactor's operations is utilized for graduate projects. Twenty percent is used for the production of radioisotopes and the remaining twenty percent is used for research and training. Soon this will also include a program for the newly developed undergraduate curriculum in Nuclear Engineering.

A new method of determining the fission fragment mass yield in the fission of U-235 has been developed by Professor Bernard N. Wehring and a graduate student Gino DiIorio. A fission fragment mass spectrometer, Hiawatha, will not only provide a new method of determining mass yields from fission, but also has the potential for determining little known nuclide yields from fusion.

A brilliant blue flash that occurs with a sudden release of energy is the major trademark of a T.R.I.G.A. reactor. The power is increased from an electromagnetic radiation that is emitted when charged particles (electrons) are traveling through a transparent medium (water) faster than light travels through the same medium.

The operation of the reactor can be viewed from above the reactor core. Ample shielding is provided by 16 feet of water. Seven and one-half feet of high density concrete surround the reactor in the horizontal direction. Radiation levels are monitored at all times. An exhaust monitor, an air particle monitor, a water monitor and 10 area monitors are in operation at all times and a visible and audible alarm is set off when any one is triggered. Safety devices are designed into the reactor system, however, during the 15 years the reactor has been in operation, the situation has never occurred to use them.



A pair of Nuclear Engineering students explain the control room of the Triga Reactor located on campus.

## Improving emissions

With most endeavors you get out what you put in, but two UIUC engineers hope to get a lot less than usual out of their endeavor when it is completed. Their project is a new kind of engine for automobiles that will give high fuel economy but will produce a much lower quantity of polluting emissions than current automobiles produce.

The fuel burned in a normal automobile engine is a rather uniform blend of gasoline and air that is mixed in the carburetor. The imperfect burning of this fuel results in hydrocarbons, carbon monoxide, and nitric oxides being emitted into the air. The amount of these discharges can be somewhat controlled by regulation of the carburetor. If it is adjusted to "run rich," allowing a little more gasoline in the mixture, more hydrocarbons and carbon monoxide are emitted. If it is adjusted to "run lean," allowing more air in the mixture, the nitric oxide emissions increase. There is

a point at which a lean-running engine would have very low emission of all three pollutants, but car engines as they are currently designed run very poorly, to the point of impracticality, at this level.

A diesel engine, which is designed differently, is capable of running lean to a much greater degree than a car engine, making it one of the most efficient and least polluting engines on the road. Diesel trucks are believed to belch great quantities of smoke and soot into the air, but actually this rarely happens because of the engine's efficiency. It is a type of "stratified charge" engine, stratified because different mixtures of fuel and air are used in different parts of the engine. This results in better fuel burning and considerably less hydrocarbon and carbon monoxide emission, even though it smells worse.

Professors S. C. Sorenson and W. L. Hull, Department of

Mechanical and Industrial Engineering, are working on a gasoline engine that operates in a way similar to a diesel engine. Their engine will have two carburetors, one small and one large, feeding two combustion chambers inside the engine. The large carburetor will be designed to provide a lean mixture for burning in the main combustion chamber. To improve the efficiency of the burning of this mixture, a rich fuel mixture in the smaller precombustion chamber will burn first and ignite the lean mixture, giving it a boost. This will result in very low emissions and acceptable engine performance. The primary goal is to increase fuel economy, but in designing the engine to do so, the researchers expect that emissions also can be kept to a minimum. In addition to building experimental engines, they plan eventually to develop a computer model to optimize fuel economy and performance in the engine.

Sorenson and Hull will use an unusual technique for studying the ignition and burning of fuel in their new engine. By building one engine somewhat taller than usual, they will have room to insert a slanted mirror beneath the combustion section of the engine, in a cut-away section of the piston area. The piston will be fitted with a transparent top. Using a high-speed motion picture camera aimed at the mirror, they will take movies of the combustion process, and use the information to figure out adjustments and improvements.

Auto companies have shown interest in this type of engine which, when perfected, will make add-on emission control equipment unnecessary and will provide good performance as well. Sorenson and Hull are enthusiastic about their particular investigation, and apparently have what it takes—a lot of drive—to make it successful.

# ENGINEERING PHYSICS

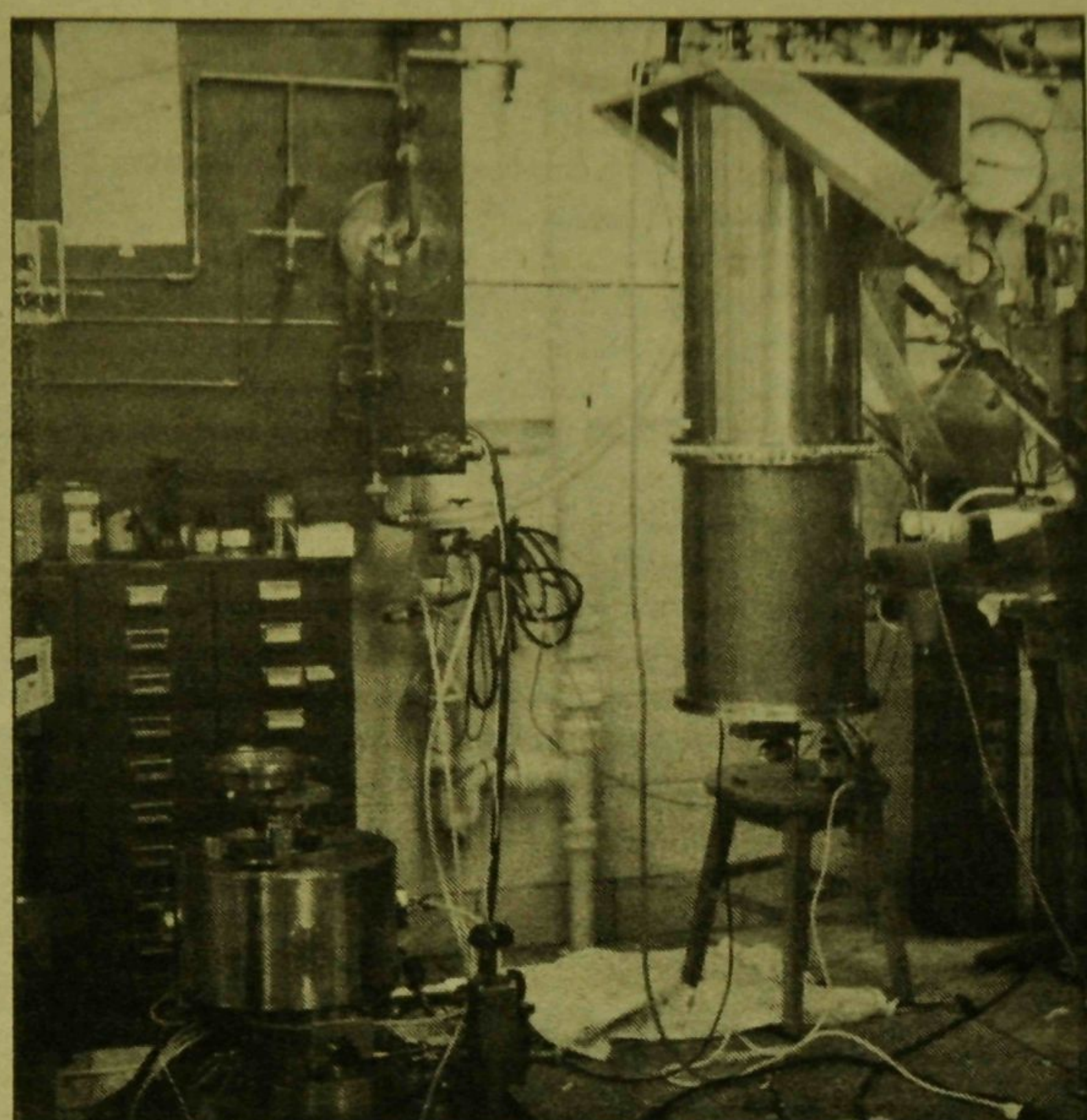
Physics is the study of energy, matter, and their relationships. Although physics is the most abstract and theoretical of the physical sciences, it also has very practical applications. By discovering and understanding the basic principles governing such things as density, pressure, gravity, electric and magnetic forces, and friction, physicists have enabled man to use many formerly untapped resources and techniques such as nuclear energy, electronics, and rocket propulsion. Physicists may be engaged either in fundamental research in which they construct mathematical theories, perform experiments, or develop complex equipment, or in applied physics in which they use acquired information to solve practical problems or develop new techniques or products.

Physics, like many of the other sciences, is a complex field and requires specialization. These specialties include mechanics, thermal phenomena, nuclear and high energy physics, optics, acoustics, fluids, electromagnetic waves, electronics, atomic and molecular physics, solid-state physics, and theoretical physics. In addition, physicists often apply their knowledge to other disciplines, creating whole new fields of study and research, such as biophysics, geophysics, and astrophysics. In the physics curriculum, advanced courses in

physics and mathematics are emphasized, but there is a liberal allowance of electives which the student may use to study a particular field of engineering or other areas such as biological sciences in which he may be interested.

A bachelor's degree in Engineering Physics prepares students for direct entry into careers in industry or government laboratories. The degree also prepares students for graduate school in physics or various branches of engineering, a program that can be especially attractive if the student chooses his technical electives wisely. Considerable latitude in the requirements is allowed for students with carefully planned programs. Some students use Engineering Physics as basic preparation for medical school, business and other careers. However, most students—about two thirds—go on to graduate school, many of them in physics.

Physicists employed in private industry or government are working primarily as researchers and project administrators. The electronics industry is the single largest employer of physicists, but many are employed by the ordnance, chemical, aerospace, instrument, and machinery industries. Others are employed by private consulting and research firms, engineering and architectural service industries, and



Physics staff and students carry on research at liquid-helium temperatures using this apparatus at the Materials research Laboratory.

commercial laboratories. The federal government employs many physicists in various fields, including the areas of defense, standards, aeronautics, and basic research. Included in the latter are nuclear physics and the large accelerator programs, nuclear power, fusion research, and other energy studies.

Many physicists are employed as teachers and researchers in colleges and universities. Junior

college teaching requires the masters degree. Many four-year colleges and all universities require the Ph.D. degree. In universities research and the direction of graduate students is a major activity of the faculty.

Physics graduates with a bachelor's degree can find applied research jobs with industry and government; most advanced and

cont. on page 19

## Job outlook from page 3

for a new job. Fortunately, a number of companies are still looking for experienced engineers, and these people did not have too much difficulty in relocating. The Engineering Placement Office helps these people relocate and an average of 10-15 alumni per month find new jobs through using the Placement Office services.

Another method by which these alumni find jobs is in the Job Opportunity Bulletin issued by the Engineering Placement Office every two weeks. It reports all of the job vacancies that have come to our attention from employers who write us. The number of job opportunities in current bulletins is not significantly different from the number a year ago.

In view of all the above, what should the high school junior or senior do today in planning a career for the future? Young people with an aptitude for science and mathematics and with a keen interest in solving problems should not be deterred from considering a career in engineering or science. However the fact that the job market looks good for engineers is not sufficient reason for a high school senior to enter the field if natural inclinations lead elsewhere. This is where the high school counselor and the University of Illinois Student Counseling Service can be of help to students wrestling with career decisions. The Engineering Placement Office also has an excellent career planning workbook which is available for free distribution. High school seniors should seek confirmation of their aptitude for engineering and only then should they enter the field.

A student's interest is probably

as good a guide as any for initial selection of college careers. Students are seldom interested in mathematics, physics, and chemistry unless they are good in these fields. Experience has shown that students who do well in these subjects also have the ability to do well in engineering if they are motivated and have sufficient interest. Many students do not know whether or not they have an interest in engineering because of a lack of experience in the field. If you find yourself in this category, this should not complicate your decision since you may enjoy solving problems and taking laboratory courses. If so, engineering should definitely be one of the alternatives you consider as a career since these interests are common to engineers.

Many students have a tendency to think in terms of salaries when choosing a career. There is probably no more short-sighted method that one could choose for beginning a career than by simply selecting the highest paid profession. Many, many years of experience has shown that graduates who are happy with their work and really enjoy it are much better paid than those who are unhappy in their work and constantly changing jobs. If you are well-suited to be an engineer, the salary will take care of itself and reasonable salary increases may be expected throughout your professional life. An Engineers' Joint Council report shows that 15 years after their graduation half of all engineers are earning over \$20,000 a year and 10 percent of the engineers are earning \$30,000 or more 20 years after their graduation. Even with current

inflation, these are quite substantial salaries!

Certain areas in engineering have special opportunities because of the special demand for graduates in those curricula. At the present time, engineers in shortest supply are ceramic engineers, chemical engineers, metallurgical engineers, and industrial engineers. Because of the short supply, special inducements may be available such as scholarships, grants, or increased opportunities to participate in the cooperative engineering education program. Once again, though, interest comes into play in such decisions. A student should not choose one of these engineering fields over electrical or mechanical engineering simply because a grant may be available. The aptitudes for all these fields of engineering are roughly similar, but interest enters into the final decision which, many times, may be delayed until the sophomore year of college.

Additional information concerning the current job market may be obtained at the Engineering Placement Office, 109 Engineering Hall. Recent salary studies are available as well as surveys of engineering graduates five and ten years after graduation.

The career planning workbook mentioned earlier is also available in this office. Parents or others reading this article after Engineering Open House is over are especially invited to write the Engineering Placement Office for any of these brochures or with any questions concerning college or an engineering career.

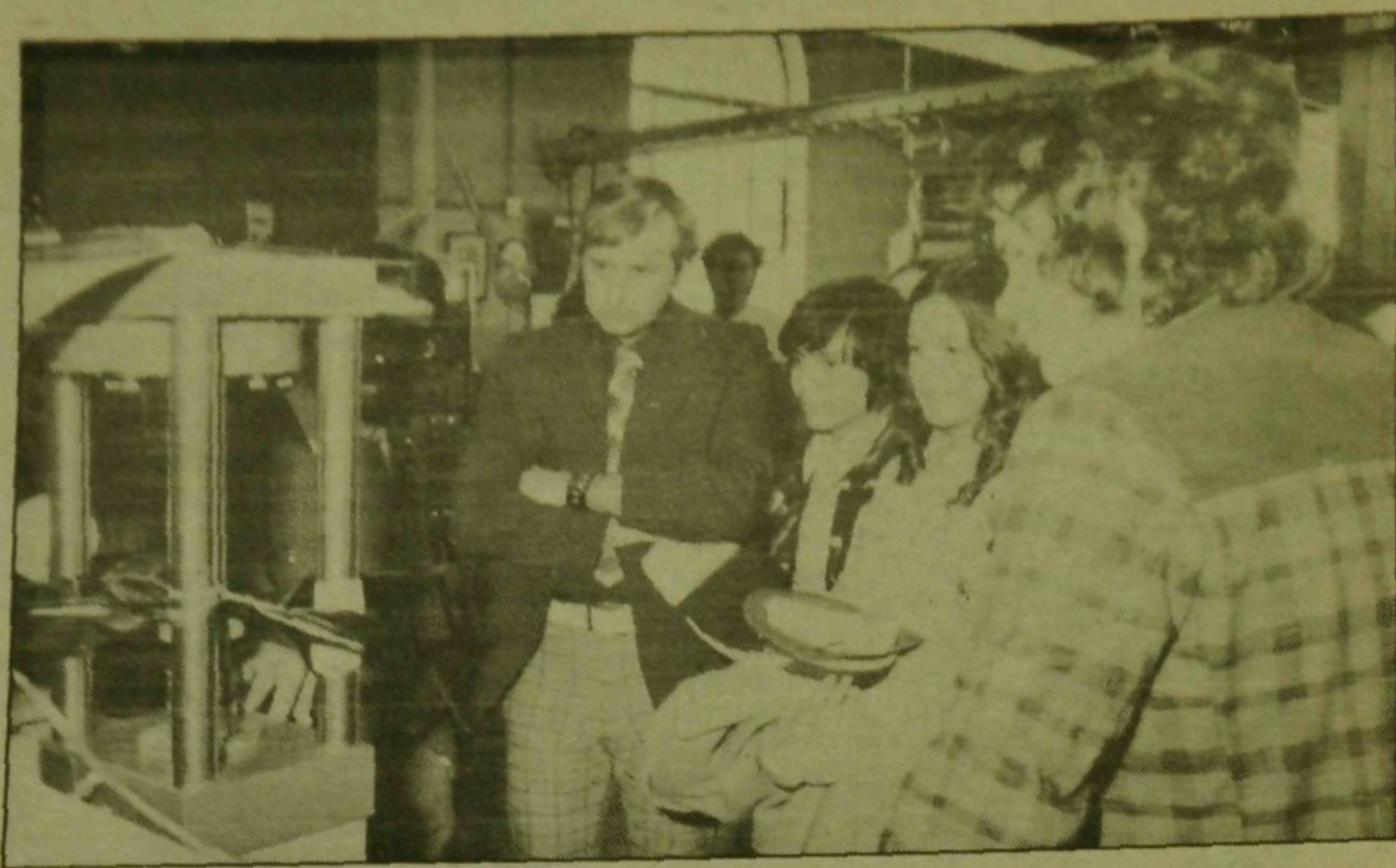
## BIOCERAMICS

Many piezoelectric ceramic materials—so called because they give off an electrical signal when pressed or bent—occur naturally, but they can also be created using a heating and cooling process in an electrical field. A prosthetic bone section made of this material can be polarized, putting the positive charges at one end and the negative charges at the other. After this process, and with the addition of a few pits to allow the bone material to grow directly into the ceramic, the piece would be ready for use, complete with its own rapid-healing mechanism. It would not be likely to be rejected by the body because its physical, mechanical, and electrical properties would "trick" the body into believing it was real bone.

Kenner and Park are testing this possibility, and are also considering other applications for the idea. They feel that it may eventually allow for the regeneration of teeth, although the constant contact of the wounded area with the outside air would make it more difficult to prevent the formation of scar tissue. They plan to explore ways to solve this problem in future research.

The work of the investigators on improving man-made materials for more compatible use with natural bones clearly has other valuable applications in bioengineering and its related fields. But support should not be difficult to come by, as long as the success holds up.

# ENGINEERING MECHANICS



An interested group listens to an Engineering Mechanics student explain the procedure for testing fan blades.

## More BITZER

without knowledge of computers will be lost."

If you saw this on television, it would be classified science fiction, but Bitzer seriously anticipates these developments.

A couple features which Bitzer doesn't expect to become implemented into PLATO systems are 3-D and added color. (Colors on the screen are currently orange and black.) "We find it doesn't pay to use color—we can demonstrate our point by boxing it in or underlining it. It's a marginal feature from the educational standpoint—something that's nice but not needed."

But 15 years ago, who wanted a color TV?

If "The Big System" as Bitzer fondly refers to what will be PLATO V is this much or even as he suggests, "perhaps more," the system and the originator certainly deserves a closer examination.

Bitzer was the second of two children. He was raised in Collinsville, where his father owned an auto dealership.

He completed his higher education at the University of Illinois, graduating with a BS in 1955, receiving a MS in 1956, and earning a Ph. D. in 1960, majoring in electrical engineering while minoring in both math and physics.

His inspiration for PLATO wasn't quite as simple as an apple falling on his noggin, but on the other hand it didn't take years of calculations.

### Education takes priority

As Bitzer relates, "At first there was only one computer, the Illiac, and the two major projects involved with it were air defense and traffic control. Finally it was decided that long range problems such as education should take priority over the short term goals. That's when meetings to determine what could be done with education and computers were being held. Those at the meetings came to the conclusion that nothing much could be worked out because the people involved in education knew very little about computers and vice versa. A letter was drawn up to that effect and before it was sent, I was consulted."

"My immediate reaction was 'that's a bunch of hogwash. It's just not true.' So I had them hold off in the mailing of the letter and set to work to see what could be done."

"Inside of one month, PLATO I was cast off an old television set

with a math lesson as its contents. The project had begun."

And that's one letter that was never sent.

The one terminal PLATO system soon evolved into PLATO II where new features were introduced or perfected such as graphic capabilities and superimposed slides.

This in turn became a 20 terminal PLATO III operation which was in use until the summer before last when it was finally phased out. It eventually contained 70 terminals in use all over town. "I would say that PLATO I and II were very close to what I expected, but PLATO III surpassed all my expectations. It was originally set up to last two years, but lasted three times longer; the storage tubes held up well and more importantly TUTOR language was developed."

### Uniform language

TUTOR was the language which allowed system people to have a uniform language and vastly expand their programming efforts.

And after PLATO III of course PLATO IV was born with still more new adaptations. The plasma display panel, of which Bitzer is co-inventor, for one. Once again Bitzer was pleased with the newest system, "It was much, much better than I anticipated, even though it took longer than expected."

At this moment, PLATO IV is still being fully implemented. With the added memory allocation among other additions due to be completed this semester, Bitzer will devote full attention to "The Big System."

Still, there should be more to it than this. After all, shouldn't every computer have two sides?

Bitzer made several other interesting comments concerning PLATO, one in response to the idea of "a computer takeover."

"That's a bunch of nonsense. They are for people's enjoyment. They're not meant to be a mystery. I'll tell you what does frighten me, though. That is the psychological dependence on PLATO."

"At times when the computer is down (due to a necessity for repairs or adjustments) you see people sitting out in the halls waiting until it's back up. It's times like these they could be playing tennis, or doing whatever things they might have, but they wait. They just don't know what to do with their time."

Engineering Mechanics is that branch of science which considers the mechanical forces on bodies and the resultant motion (if any) which those bodies undergo. The bodies can be structures, such as electric transmission towers, houses, skyscrapers, offshore drilling platforms, airplane fuselages, dams, and so on, or they can be fluids, such as waterways, exotic chemicals flowing in pipes, molten metals in foundries, aerosols, even the atmosphere (and pollution) that we breathe.

The Department of Theoretical and Applied Mechanics offers BS, MS, and PhD programs in the field of engineering mechanics (not to be confused with Mechanical Engineering, which is another discipline). The emphasis in engineering mechanics is on the analysis of given mechanical designs; the analysis can be either theoretical or experimental, or both, and it often involves computer simulation as well as mechanical testing. This kind of analysis is fundamental to the many projects conducted by the research and development (R&D) groups of most industries, governments, military agencies, and university communities.

As an undergraduate student in Engineering Mechanics, you will learn how to make meaningful engineering simplifications of

complex problems and how to solve the simplified problems in a way that will allow you to predict what will happen when a given engineering design is fabricated and put into service. At the University of Illinois, the research and teaching activities include studies in: Fluid Mechanics (gases and liquids), Solid Mechanics, Dynamics, Mechanical Properties of Materials, and Applied Mathematics. Experience has shown that the solutions to many engineering problems require a working knowledge of most, if not all, of these areas of study.

The strength of the program at the University of Illinois is revealed by a survey of the Engineering Mechanics graduates during the years 1967-1972. It was found that 46 percent immediately continued their education at the graduate level. (Over the same period, 25 percent of all graduates from the College of Engineering went immediately to advanced study.) The rest went into industry (49 percent) and military service (5 percent).

Additional information about careers in Engineering Mechanics may be obtained by writing to Prof. R. T. Shield, Head, Department of Theoretical and Applied Mechanics, University of Illinois at Urbana-Champaign, Urbana, IL 61801.

### Effectiveness

One question which has yet to be dealt with is: how effective are PLATO taught classes as compared with the conventional classroom methods?

Bitzer replied to that question in this manner: "That's really hard to say. I think it depends on the material, the student and the way it was programmed. I do feel that in one half the time the same amount of material can be presented and dealt with."

"There are other factors to consider. That is, on a computer you can't just gloss over the material, you have to get the correct answer before you can go on to the next question. This could make the student more frustrated—but he can tell exactly how well he is doing, so he can spend an appropriate amount of time on the subject."

When it was noted that there are two distinct age levels which use PLATO, the youngsters from Uni High and Leo School and the students from the U of I and Parkland Community College, Bitzer commented on whether age affected how well students learned on PLATO.

"I think there are greater correlations based on personalities than age. Of course there are some exceptions. You get people 45-50 coming back to school and they get up-tight over using a computer. They don't want to spend their tuition money to learn from a machine. But you're going to get complaints from any teaching method you use. I would generally say that the younger the students, the more flexible they are in their attitudes towards using a computer."

### Student Reactions

All this sounds fine, but what about the people who are affected the most—the students. What is their reaction?

"I can say that there have been

very few times when I have been down there (PLATO room, 165 CERL) that there haven't been some kids there. This includes all hours of the night.

"We have one of the few buildings that is open 24 hours a day, 365 days a year. Some have said we should shut down, but its too expensive. I figure it costs \$1000 an hour to close the place down. I think you'll see more buildings open longer in the future."

"The kids have really taken to it. They come here and play games and after awhile they become so fascinated they want to write material, become PLATO authors. Whatever they're doing though, they're learning."

Before any of you get the idea of going to the nearest PLATO terminal and trying it out, it should be noted that it is not that easy.

First of all there is the problem of a sign-on. Each name must be registered in a specific course and entered there by a legitimate person. With the popularity of PLATO the way it is, there is quite a waiting line for sign-ons.

One of the most popular features of PLATO is the numerous games that have programmed on the system.

Many people frown on gamemasters. But Bitzer views them in a different fashion. "I'm probably more lenient than most to the game players. I say as long as there's room for bona fide authors and students and the gamemasters aren't causing any distracton, I don't mind."

### Game Plating O.K.

"I mean the computer doesn't know it's working any harder than with a student using it and it doesn't make them last less long, and besides even if they're playing games, they're learning."

"Games help youngsters to develop strategy and that is the hardest thing to try and teach. So it's not all bad."

# More ELECTRICAL ENGINEERING

Certainly, the demand for professional competence in electronic device development and fabrication continues to grow with each passing year as the impact of new device technology is felt in the industrial and consumer marketplace. The demands for such sophisticated electronic products will continue to require the efforts of many electrical engineers prepared to work in the physical electronics area.

Electromagnetics play a major role in radio communication and is an essential part of most areas in Electrical Engineering. Radio waves are the vehicle that carry our messages. Antennas launch and capture these waves, they are transmitted within systems by means of waveguides; propagation between systems takes place in the atmosphere, sometimes through the earth or the water of the ocean. The propagation is accompanied by reflections from the ionosphere, refraction and bending in non-uniform media. The design of systems requires thorough knowledge of these phenomena. A form of communication which is growing in importance is what is commonly called "remote sensing". It consists of sending known signals in terms of the medium to be analyzed and to interpret the received signals in terms of the medium to be analyzed and to

interpret the received signals in terms of the medium properties. Radar is an example of remote sensing where distance and velocity of a target are deduced from a received echo. Ionospheric sounding is another example. Remote sensing can be used to explore the underground or to "look" inside the human body with obvious application to medicine. The area is in active development and with the help of modern computers and techniques such as holography one can hope to be able to see the invisible.

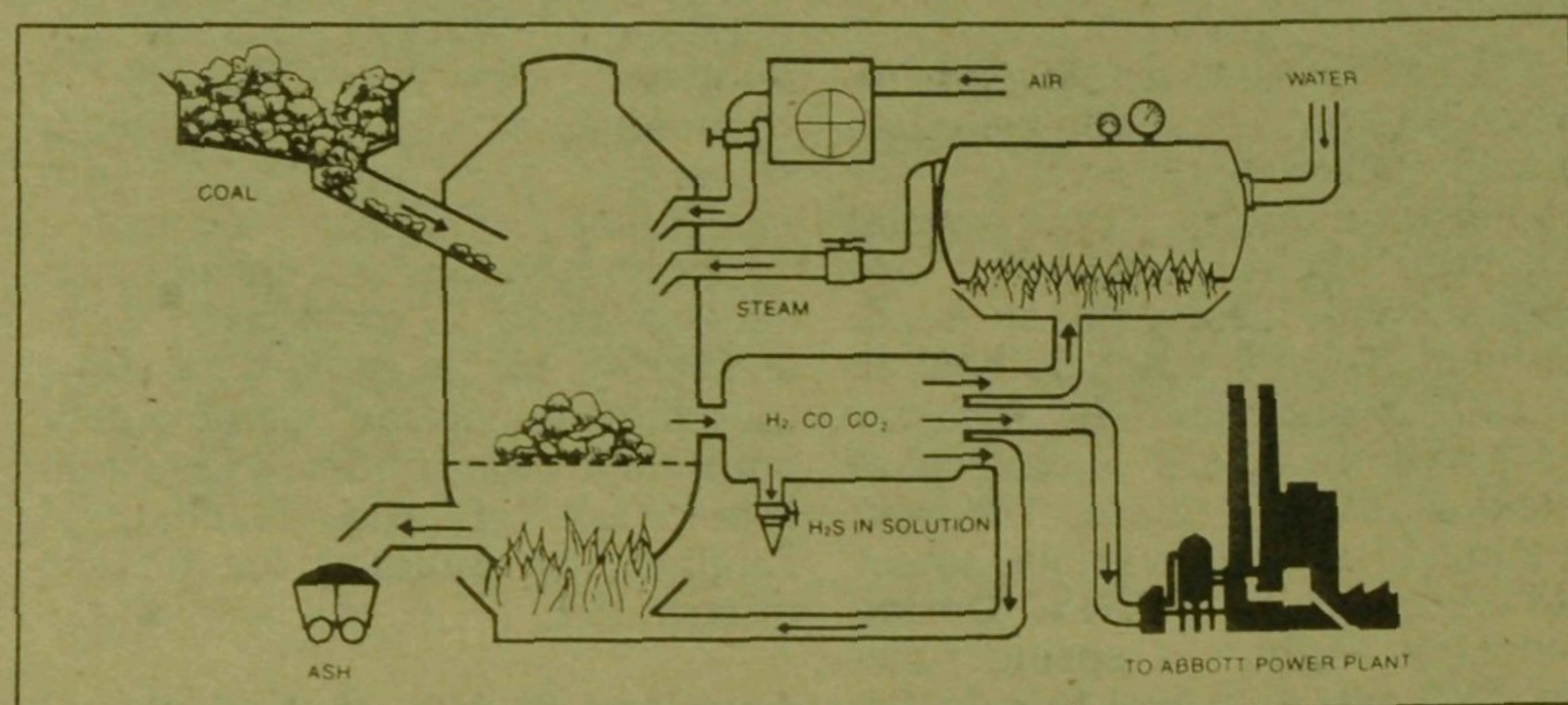
The most apparent trend in the atmospheric sciences and propagation area is the greater orientation towards radio and optical studies of the upper atmosphere, ionosphere, and space by means of remote sensing techniques. Promising areas for future breakthroughs abound in the atmospheric, environmental and space sciences. Planetary atmospheres in our solar system will be under active investigation, and studies of these are expected to yield new insights into the understanding of the complexities of Earth's atmospheric evolution and environment. Space and global satellite communications will continue to flourish in the decades ahead. High-power laser transmitting systems and sophisticated optical detection systems will be

required, as well as a clearer understanding of microwave and optical wave propagation through various media.

Applications of the analytical tools and methods of electrical engineering are not restricted to areas within the discipline. Course work and research in bioengineering, acoustics, audio, and electronic music prepare students for careers in these interesting interdisciplinary areas. For example, the traditional competence of the electrical engineer in the processing and control of information, coupled with his abilities in the design and analysis of complex systems, can

be a powerful tool in solving biological problems, including applications to medicine and quantitative studies of the relationships between biological systems and their environments.

The undergraduate program in the Department of Electrical Engineering provides a solid foundation in the fundamentals of the field. Basic knowledge is stressed that will remain valid and applicable despite rapidly changing technology. Concepts and methodologies of lasting importance are emphasized.



Engineers at the University of Illinois at Urbana-Champaign are developing the coal gasification process shown here to remove sulfur from Illinois coal by combining air, coal, and steam to produce a medium heat-capacity gas, free of sulfur. One proposal under review would provide the gas to the UIUC's Abbott Power Plant to burn in place of number two fuel oil.

## Coal gasification

Next to turning a sow's ear into a silk purse, perhaps the most difficult task facing this country is the location of an economical, clean, nonpolluting source of energy. A group of UIUC engineers think that they have a solution which appears to be almost as marvelous, and certainly more practical, than the proverbial transformation.

The state of Illinois has within its boundaries one-fifth of the nation's estimated total supply for bituminous coal, nearly 148,000,000,000 tons, more than West Virginia, Kentucky, or Pennsylvania. Coal underlies two-thirds of the state. But Illinois ranked only fourth in production in 1971, producing only half as much as West Virginia or Kentucky and

less than 80 percent as much as Pennsylvania. The reason is that nearly all Illinois coal is high in sulfur content. The distinction between high- and low-sulfur coal is vital since 1975 sulfur dioxide control regulations are so severe that they will effectively prohibit the burning of Illinois coal.

Engineers at the University of Illinois at Urbana-Champaign under the direction of S. L. Soo, B. T. Chao, J. C. Chato, and J. J. Stukel, UIUC Department of Mechanical and Industrial Engineering, have developed a process which has the potential of turning high-sulfur Illinois coal into a clean, medium-energy gas. Desulfurization is usually thought of in terms of stack gas scrubbing (removing sulfur dioxide from the

exhaust gas after the coal has been burned or coal prewashing (removing the sulfur before the coal is burned). But it can also be removed during gasification. The coal is converted to a gas which is pipelined to the customer free of problem-causing sulfur.

The gasification process converts a mixture of steam and coal to hydrogen, carbon monoxide, carbon dioxide, hydrogen sulfide, and other constituents. Steam for the process is produced by burning part of the gas generated. In the process, the sulfur in the coal is converted to hydrogen sulfide which is readily removable. The coal used can be "run of the mine" which requires no sizing, grading, or preprocessing. When burned in a power plant, the gas causes no significant pollution and permits more efficient operation at lower stack gas temperatures.

Numerous schemes have been proposed (and some are in operation) for the gasification of coal. But the UIUC proposal differs in a number of important respects. This design is directed toward small municipal power plants, industrial-sized power plants, and other medium-sized users with an operating capacity of 700 to 800 tons of coal per day. Giant gasification plants of 10,000 tons or more are currently under design or construction using other principles of gasification.

The produced gas is a medium-Btu gas of approximately 340 Btu-cu ft (British thermal units per cubic foot). High-Btu gasses (1,000 Btu-cu ft) require additional

processing, such as methanation. Low-Btu gasses (150 Btu-cu ft) require a great deal of auxiliary equipment. The UIUC process uses steam instead of oxygen, does not require preprocessing of the coal, and can accommodate coal of varying quality.

Water requirements for both cooling and consumption, which can be quite prodigious for some gasification schemes, are relatively modest. A ten-acre spray pond will serve for cooling and the amount of water consumed is less than 120 gallons per minute (half an acre-foot per day).

As a demonstration of the process, UIUC engineers have proposed a gasification plant to be constructed on the Urbana-Champaign campus to provide gas to the UIUC Abbott Power Plant which currently burns oil. Since oil and gas burners are readily interchangeable, the power plant can continue operation unabated with either gas or oil as circumstances dictate. Since the power plant has been subjected to the same skyrocketing fuel costs as other consumers (the price of number two fuel oil is expected to have tripled by 1976 over its 1972 prices), it welcomes the proposed gasification facility which has the potential to reduce costs without the necessity and added expense of yet unproven stack gas scrubbers in order to burn cheaper, more plentiful Illinois coal. At \$20 per ton, the estimated recoverable coal reserves of Illinois are valued at \$1.5 trillion.

## Quiz answers

1. False. The foreign language requirement has been dropped in the College of Engineering at the University of Illinois.
2. There are 7. Bradley, Southern Illinois University-Carbondale and Edwardsville, Illinois Institute of Technology, Northwestern, University of Illinois-Chicago Circle and Urbana-Champaign.
3. False. The College of Engineering accepts applications up to June or July.
4. According to the Engineering Manpower Commission of Engineers Joint Council there will be 36,000 graduating engineers in the class of 1976.
5. According to the Bureau of Labor Statistics, the number of new engineering graduates needed in 1976 will be 48,000.
6. According to Dean D. Opperman of the University of Illinois Engineering Placement Office, the starting salaries for graduating engineers is \$12,000.
7. Dean H. Wakeland of the University of Illinois College of Engineering estimates that 5 percent of freshmen are women with an increase in demand of 100 percent.
8. According to Dean Wakeland, 4 percent of engineering graduates represent minority groups.
9. The majority of Illinois Community Colleges have pre-engineering programs consisting of math, physics, drafting, and other basic engineering courses.

## Thank You

The editors would like to extend a special thanks to Engineering Outlook for supplying the technical

stories. We would also like to thank Fred Kroner and the Technograph for the article on Dr. Bitzer.

# Engineering Societies

## UIUC Student Chapters of Professional Societies

While in the process of becoming the type of engineer you want to become, don't overlook opportunities to broaden your exposure! You may discover a new area of interest that is in harmony with your goals. The UIUC student branches of professional engineering societies are open to participation by all interested engineering students—you don't have to be a particular major to get in on the action. Here are some at a glance:

**American Foundrymen's Society  
(AFS)**

The AFS works to develop interest in foundries and to establish contacts between students and the people in industry. Two special meetings held annually are designed with these goals in mind. "Student Night" which is held in the fall, is sponsored by industry and gives members a chance to attend a foundry-related industry meeting to discuss various topics with engineers in the field. During "Industry Night," a spring function, AFS acts as a host to industry people and provides more opportunities for contact which may result in summer employment possibilities. Throughout the year plant trips and guest speakers help make the engineer's role in industry clear, meaningful, and attractive to AFS members. Talk to the society's adviser, Professor James L. Leach, about activities and membership.

**American Institute of Aeronautics  
and Astronautics (AIAA)**

In this society aeronautics and astronautics enthusiasts keep abreast of developments in the

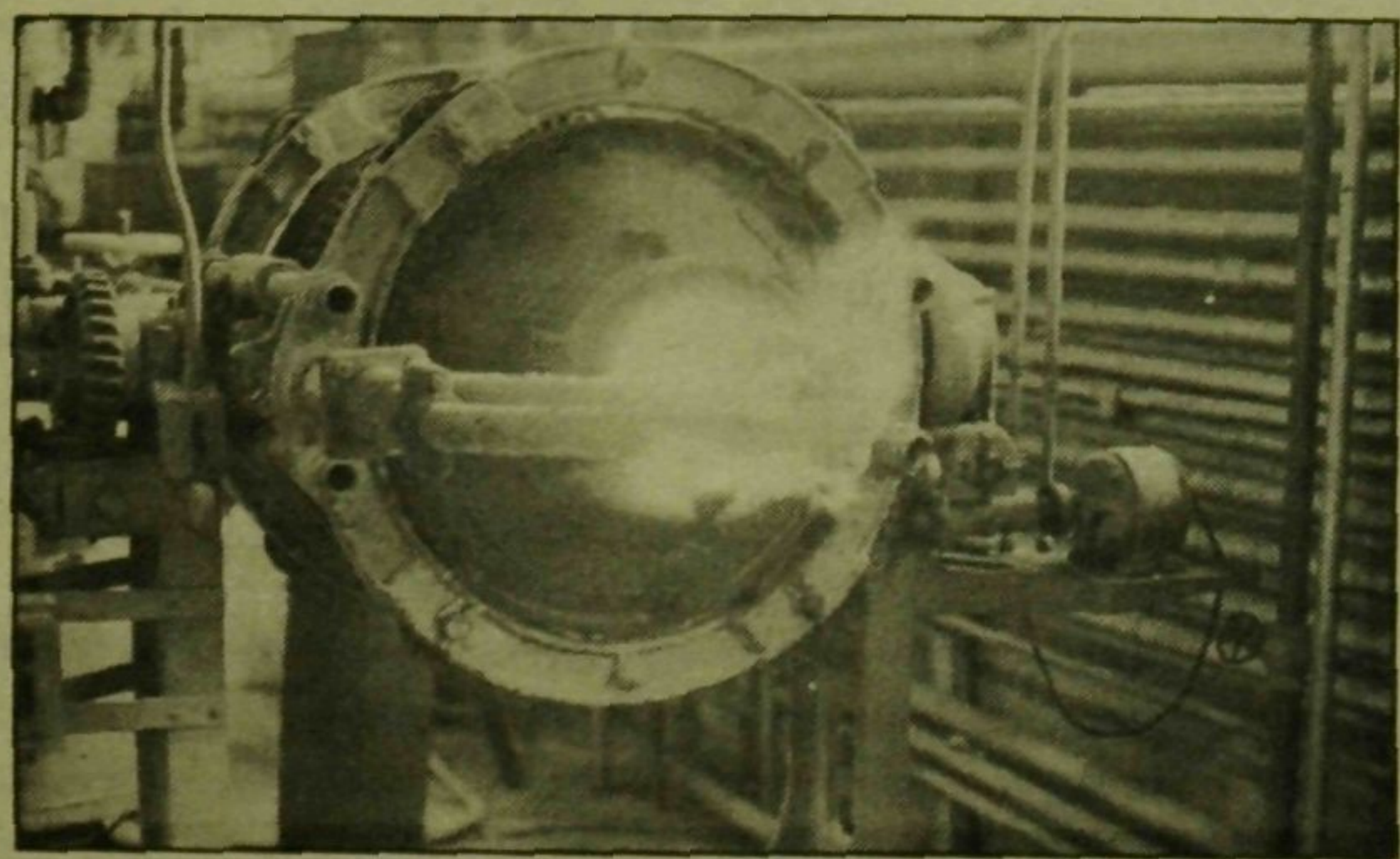
learning in their projects. The society also offers a number of advantages to members, from a discount price on the Chemical Engineering Handbook to the chance to win friends and influence other chemical engineers at the annual picnic. Professor Richard C. Alkire, the chapter's adviser, always welcomes inquiries.

**American Institute of Industrial Engineers (AIIE)**

People and their roles in integrated systems provide food for thought and study in this professional society. Here there are extra opportunities to understand these systems better by applying knowledge from the mathematical, physical, and social sciences. Contact with professionals is provided in the monthly meetings and in informal get-togethers, including the society's picnic. These allow members to interact comfortably with each other's ideas. Check in room 232 of the Mechanical Engineering Building for further information.

**American Society of Agricultural Engineers (ASAE)**

UIUC's student chapter of the ASAE provides many occasions for learning and experience in agricultural engineering, including training in communications with the production of two yearly publications. A number of social events combined with numerous field trips and lectures by prominent professionals complete a well-rounded, stimulating program of activities. All of the agricultural engineering faculty are enthusiastically involved and any of them can give you more information.



*This rotary smelter is used by students in various lab courses. It can make up to 50 pounds of glass in a single firing.*

field through two field magazines, guest speakers, field trips, and movies. The field trips have taken them to Florida for an Apollo space launch, to St. Louis to watch jets being produced, and to other universities to present papers.

**American Institute of Chemical Engineers (AIChE)**

The monthly meetings and activities of the AICHE are aimed at helping members get acquainted with the faculty and other professionals as well as with the many ways chemical engineering can be put to use. The group organizes the chemical engineering display for Engineering Open House, through which students share what they are

**American Society of Civil Engineers (ASCE)**

Bringing together civil engineers in practical, fun, and enlightening situations is the goal of ASCE. Along with visits to consulting and manufacturing firms, construction sites, and conventions, the society holds such events as a concrete canoe race and a balsa wood model span contest. It's a lot of fun and gives you a chance to apply all that "book knowledge." Professor James E. Stallmeyer will be happy to fill you in.

**American Society of Mechanical Engineers (ASME)**

Joining this society puts you automatically in touch with up-to-date developments in the field through your monthly copy of the professional magazine **Mechanical Engineering**. In addition, with a little initiative of your own, you can buy technical papers (members get five free per year) and other



The hybrid car is one example of the many activities engineering students have participated in during recent years.

## American Academy of Mechanics (AAM)

Students interested in mechanics will find this society a valuable vehicle for exchanging ideas as well as learning new facts and applications. Discussions and lectures on such areas as fluid mechanics, solid mechanics, and mechanical properties of materials help members develop a good background, a working relationship with the faculty, greater participation in paper competitions, and other activities add to understanding. Professor James W. Phillips has all the details.

The Institute of Electrical and  
Electronics Engineers (IEEE)

The IEEE is the world's largest engineering society, and 20,000 of its 160,000 members are students. Thirty-one groups and societies that represent technically specialized areas of interest have been formed with IEEE. Through their publications and meetings you can keep abreast of the latest developments, trade ideas, and grow professionally in your own area of interest.

As a member you receive IEEE's monthly magazine and quarterly student newsletter which not only keep you up-to-date on trends in the field but fill you in on the job market, career information, and what other IEEE student branches are doing. And to help you increase your own expertise, there is the Student Paper Contest, giving you the opportunity for self-expression, international recognition, and cash awards. Stop in 247 Electrical Engineering Building to find out more about what the IEEE can do for you.

**The Illinois Society of General Engineers (ISGE)**

This society is a group of general engineering students at the university who gather together with faculty for social, educational, and service activities. The five officers who govern the society are always open to suggestions for enlightening and enjoyable activities; the format of meetings has varied from a bowling tournament to a panel on how to get a summer job. For information on membership and meetings, check in room 117 of the Transportation Building.

## The Institute of Traffic Engineers (ITE)

The ITE is for those civil engineers interested in transportation and traffic engineering. Experts come to the ITE and discuss at its meetings a number of topics related to the field. Other activities and field trips take the members to the professionals, where they can further broaden their scope. For more information, drop in 418 Engineering Hall or call 333-1270.

**The University of Illinois Physics Society**

Physics is a science that has some relationship to every aspect of engineering, and the Physics Society acquaints its members with such important areas as astrophysics, biophysics, low temperature physics, high energy physics, and their smaller divisions. In addition to discussions of these areas, often including firsthand looks at related laboratory procedures, the society schedules trips to such places as Fermi National Accelerator Labs, Argonne, Bell Labs, and the Radio Telescope at Danville.

## The Society of Cooperative Engineers

The Cooperative Education Program is a practical way for engineering students to gain experience along with their degrees, and the Society of Cooperative Engineers is an organization for those interested in and-or participating in the program. Each semester the society undertakes several projects to increase awareness of the advantages of the program by taking an active role in promoting academic credit for work experience and general favorable attitudes toward mixing academic training with applied outside occupations. Dean D.R. Opperman, 109 Engineering Hall, can tell you more.

## REFRESHMENTS

- hot dogs
- coffee
- candy bars
- Coca Cola and Orange
- potato chips

Front Yard  
of Engineering Hall  
on  
Green Street  
by Engineering Council



revolutions in engineering

# Society of Women Engineers

by Carol Woodyard and Linda Aberle

Do you enjoy math problems and find them challenging? How about physics and chemistry—do you feel a deep sense of satisfaction knowing that you can handle these sciences? Have you ever thought about extending your capabilities to a career that would utilize them? If you have, but you couldn't come up with an answer, consider the following: engineering.

First, let's get the facts straight. Computer design and development is no more masculine than interior and fashion design is feminine. Engineers do not have to be physically strong for they don't work on dirty assembly lines. Analytical minds are more important than mechanical abilities. And engineers do find themselves in positions of responsibility and leadership.

Now the questions start coming! The student branch of the Society of Women Engineers at the University of Illinois can help answer all your questions. One of the goals of the society is to encourage female high school students to pursue their scientific interests, and to inform them of the opportunities that await them in a career as an engineer.

What do engineers do? SWE has been answering this question many times and in many ways. Field trips to a radio telescope facility, industrial plants, and a nuclear reactor are only a sample of the

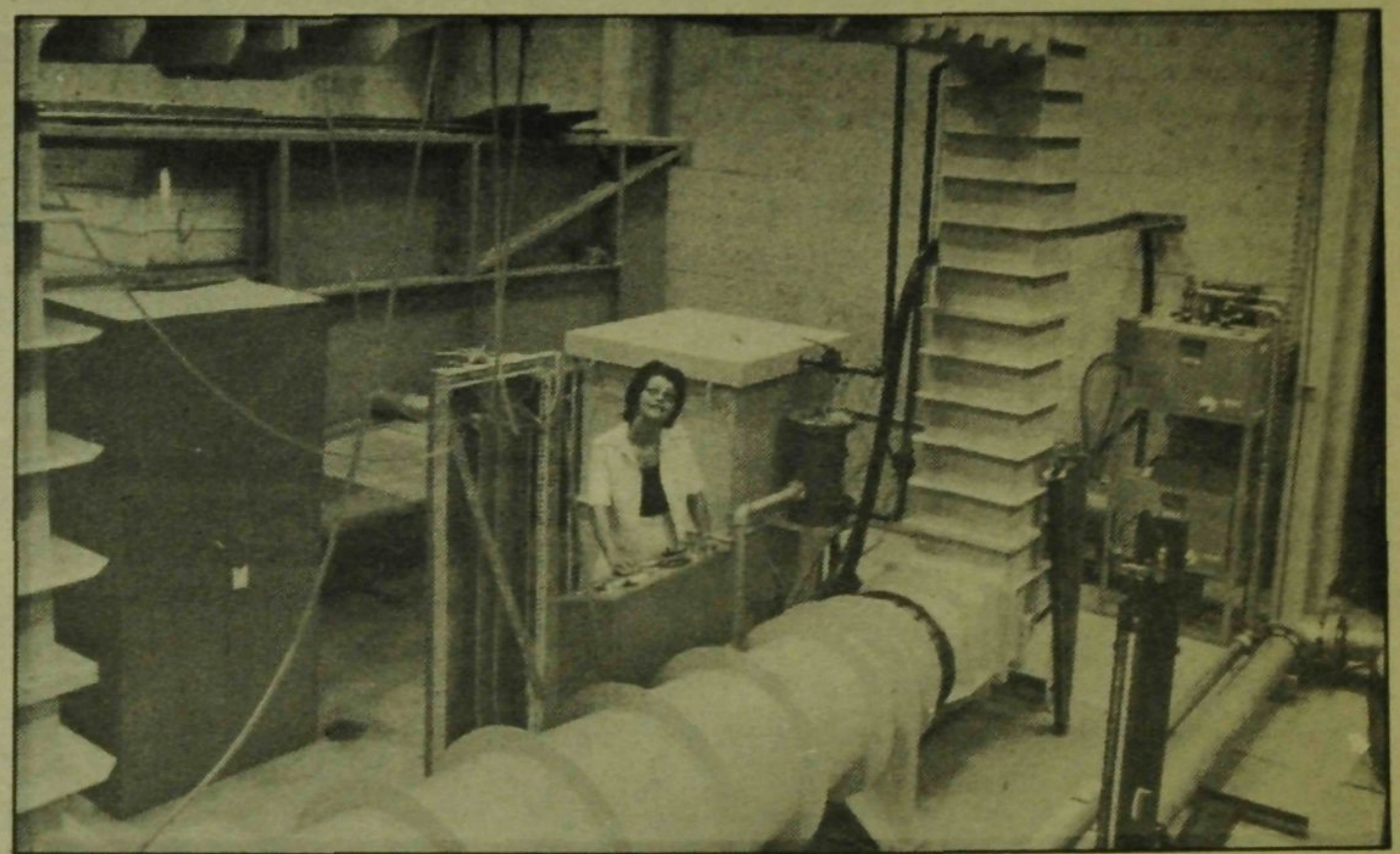
activities members have attended so that some of their questions could be answered. Guest speakers give presentations on topics ranging from working at a large research laboratory to teaching through the computer-based program known as PLATO to career opportunities. They are often helpful in alleviating members' anxieties about what it is like to be an engineer. The most important way in which SWE has answered some questions is in sponsoring career counseling conferences on women in engineering. Women representing industry, government, and academia discuss various aspects of engineering with high school girls from every corner of the state. The reactions and responses of the girls following the conference can be summed up in three words: "It was great!"

Besides sponsoring conferences, taking field trips, and hosting guest speakers, SWE is a source of new friendships with fellow students and with the faculty. Social activities include a picnic in the fall, a Christmas party, and a Mom's Day luncheon. In addition, SWE holds joint meetings with other on-campus professional societies.

Consider the following: "My previous engineering jobs in design or system integration have been on products such as weather

satellites, jet engines, and nuclear reactors. This succession of different, responsible jobs has meant a career that never gets stale." And that is what engineering is all

about; challenging, stimulating, diverse, satisfying. You have nothing to lose and everything to gain.



Women in all fields of engineering find challenging careers in industry, government, and academia.

## More J.E.T.S.

JETS occurs each summer when it sponsors four two-week summer programs with three colleges of engineering. These programs are held at Bradley University in Peoria, the University of Illinois at Chicago Circle, and two programs at the Urbana-Champaign campus of the University of Illinois. These programs, which accommodate approximately 40 students each, bring high-ability high school students, who will be entering their senior year in the fall following the program, to the college campuses.

During those two weeks, the participants are exposed to engineering lectures, laboratories, computers, discussion periods, and mathematics as applied to solving engineering problems. They leave campus with a better understanding of what engineering is and what it entails. Staff members on the three campuses contribute their time and efforts to these programs. The only charge to the student is for room, board, and equipment. Scholarships are available for participants with demonstrated financial need.

The second program held at Urbana-Champaign is the Minority Introduction to Engineering (MITE) program. MITE was held at ten different university campuses across the country during the summer of 1974. Through MITE, over 300 minority students were able to find out about engineering. MITE evolved from the Inner-City Engineering Orientation Program, which was first held on the Urbana-Champaign campus in 1969, and which has continued each summer since. These programs are funded by industrial contributions so that participants attend at no cost to themselves.

JETS in Illinois offers any high school student an opportunity to investigate engineering as a possible career choice. It poses no obligations and can only benefit a student. For schools where chapters do not exist, individual memberships are available.

State Headquarters are located in Room 214 Transportation Building, University of Illinois, Urbana, Illinois 61801.

## Recycled concrete

Most of us don't have a lot to do with concrete in the first place, but doing something with it the second time around is a problem even for construction engineers. Old, unused concrete at building sites contributes considerably to the solid waste problem. Joel Smason, senior in civil engineering, had an idea for dealing with the problem. During this past summer, under the direction of Professor J. Francis Young, he decided to investigate recycling concrete rubble to be used again as cement.

Concrete is a mixture of cement, sand, and gravel. Cement is the bonding agent used to hold the elements of concrete together. It is usually made of limestone and clay fired in a kiln at temperatures between 2700 degrees and 3000 degrees F. Smason planned to crush the concrete rubble and mix and heat it again to turn it into cement. He had a few more

problems with the project than he anticipated.

Both Smason and Young believed that sodium, potassium, and magnesium—three trace elements found in concrete—would prove to be a problem in making their recycled cement reusable. The occurrence of these three elements is kept limited by specifications because they lead to problems in the strength and life span of the concrete. But the researchers found that, within the limits of their study at least, the elements would not be present in excessive quantities.

As an environmental concern, however, the plan has definite possibilities. Smason is in the process of completing his report, after which he will move on to other investigations—leaving his footprint in the wet cement of engineering history.

## PHYSICS from page 15

administrative positions require M.S. or Ph.D. degrees. Physics majors who have completed the necessary education courses can find teaching jobs in secondary schools. Many physics graduates take jobs as trainees in business or government, or sales or technical relations jobs with various industries, or continue their education in other fields such as chemistry, medicine, biophysics, or engineering.

Students interested in the Engineering Physics curriculum may wish to visit some of the laboratories and talk to individual

professors. The Physics Department Office is 231 Physics Building, and the telephone is (217) 333-3114. Please feel free to visit at any time. However, advance notice will assure you of the opportunity of talking to the professor most suited to answer your questions. The Physics Library in 204 Physics Building contains a complete collection of the journals and books used in research and teaching in physics. A source of general information in physics is the American Institute of Physics, 335 East 45th Street, New York, New York 10017.

St. Patrick, the patron saint of engineers, will once again be honored at a special dance. The St. Pat's Ball has always been the climactic end of every successful EOH. It is at this dance that the "coveted" EOH awards are presented and a few chosen engineering students are honored by being made Knights of St. Pat.

The ball is a semi-formal dinner-dance which this year will be held at the Century Twentyone in Champaign on March 6. The dinner will begin at 7 p.m., followed by the dance which will run from 9 to 12 p.m. Of course,

there will be a cash bar to celebrate the closing of another successful Open House.

The Rudy James band, which is well known to all who attend ballroom dances on campus, will provide music for the dance.

So be sure to come to St. Pat's Ball where you can eat, drink and dance your troubles away. The dance is open to all, as you don't have to be in engineering to enjoy yourself! Tickets can be purchased at 300 Engineering Hall. Bring a friend for a good time will surely be had by all.

## St. Pat's Ball Approaches



(l to r) Ed Graddy, Mike Miller, H.O. Barthel, Mike Bragg



(l to r) D. H. Cooper, Greg Ives, Mike Brenneman, Frank Canzilino



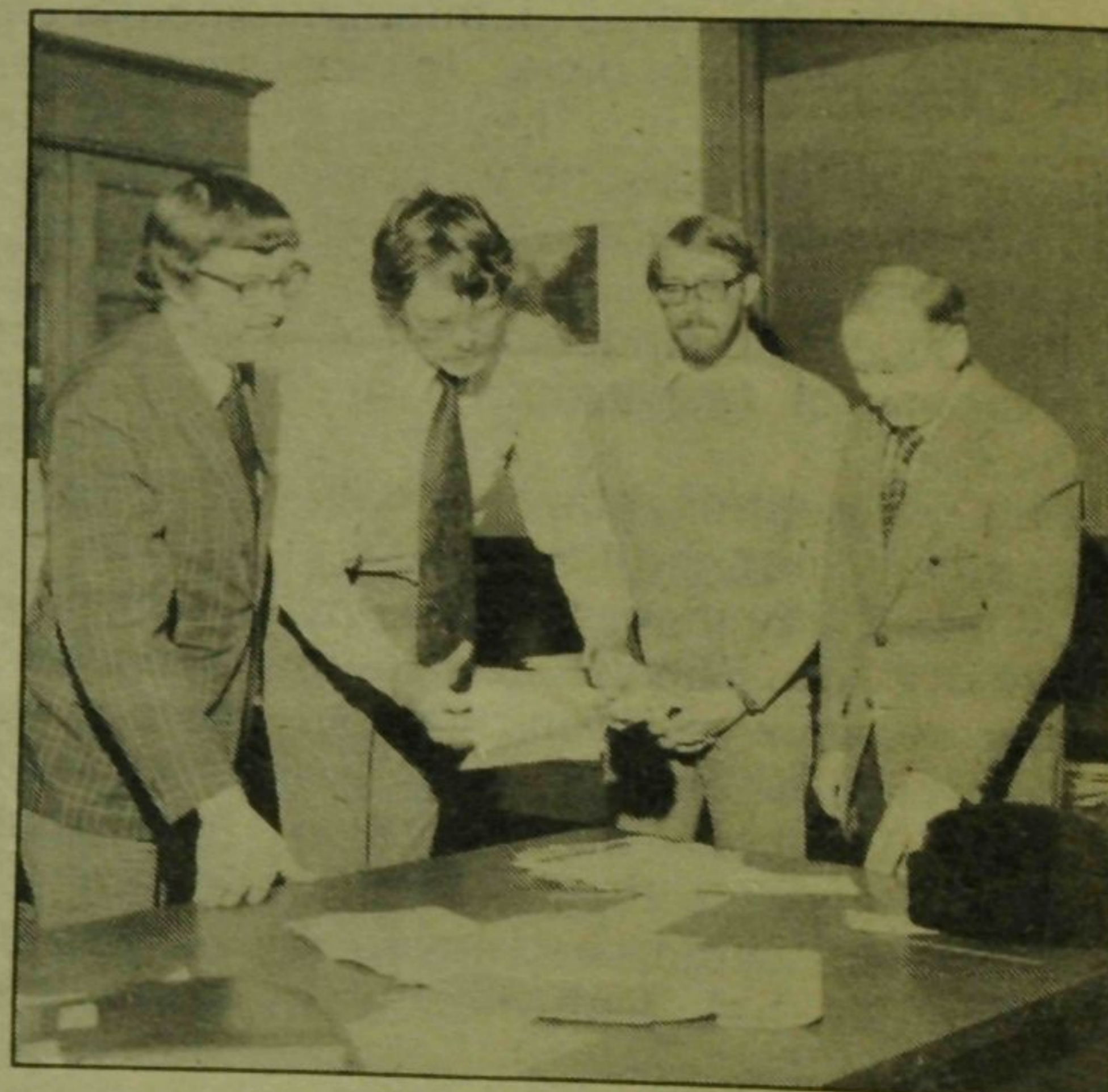
(l to r) Petere Mine, Becky Brase, Larry Shulz, Chairman; Tom Glenn, SITE Chairman; Chris Billing



(l to r) Philip Chumbley, Robert Perchak, William Streicher, Michael Streck

### Central Committee

Larry Schulz	Chris Billing
Tom Glenn	Becky Brase
Nick Hoyle	Paula Keck
Petere Miner	Mike Pogue
Carol Woodyard	



(l to r) D.H. Offner, P.B.W. Kirk, Bob Watson, W.J. Worley

## Faculty Advisors & Department Chairmen

### Aeronautical and Astronautical

H.O. Barthel  
A.R. Zak  
Mike Miller  
Mike Bragg

### Agricultural

D.H. Vanderholm  
Mike Brenneman

### Ceramics

C.G. Bergeron  
William Streicher  
Ed Graddy

### Chemical

R.L. Sani  
Bill Martin

### Civil

J.E. Stallmeyer  
Gary Ehlert

### Computer Science

S.R. Ray  
Mike Streck

### Electrical

D.H. Cooper  
Jack Steiner

### General

H.J. Sprengel  
Greg Ives

### Industrial and Mechanical

D.H. Offner  
Larry Brand  
Sandra Andrews

### Metallurgical

H. Fraser  
Frank Canazolino

### Nuclear

F. Southworth  
Bob Williams

### Physics

T.B.W. Kirk  
Bob Perchak  
Philip Chumbley  
Boyce Grier

### Theoretical and Applied Mechanics

W.J. Worley  
Bob Watson